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# *Rocky Mountain Bighorn Sheep of Montana*

by
Faye M. Couey

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A Bighorn Group in Lower
Sun River Canyon

MONTANA FISH AND GAME COMMISSION

# ROCKY MOUNTAIN BIGHORN SHEEP OF MONTANA

by

FAYE M. COUEY

Big Game Biologist

Bulletin No. 2

Surveys and Investigations
of Montana's Wildlife Resources
Under Federal Aid in Wildlife Restoration Act
Project 1-R

Supervising Personnel:
R. H. Lambeth, State Game Warden
R. F. Cooney, Restoration Division Director
W. K. Thompson, Assistant Restoration Division Director

1950

Rocky Mountain Bighorn Sheep

in Montana


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# ROCKY MOUNTAIN BIGHORN SHEEP

# IN MONTANA

by

Faye M. Couey

## I. INTRODUCTION

Following Montana's acceptance of the Federal Aid to Wildlife Restoration program, the State Fish and Game Department proposed the project on Bighorn Sheep Investigations. The purpose of this work was to gain sufficient information to formulate a plan of management for this comparatively rare big game animal.

This work was carried on under the supervision of Dr. J. S. McFarland, State Game Warden; Robert F. Cooney, Director, Wildlife Restoration Division; and was supervised in the field by J. A. Parsell, Big Game Leader of the Wildlife Restoration Division. The period of investigation began in May 1942 and ended in June 1944. The writer carried on the work in the field alone, although an assistant was employed during the winter months at the Allan Ranch, center of winter range, to help gain a more thorough check on bighorn conditions and habits.

The only other concerted investigation of bighorns in the State has been an eight-month cooperative, one-man study (October 15, 1940, to June 15, 1941), involving the State Fish and Game Department and the Forest Service, and conducted on the Ural-Tweed band located on the Kootenai River.

Since the completion of this study in 1944 there have been numerous notes and observations gathered which have increased the value of the report. This report represents a revision and bringing up to date of the original study.

Acknowledgements are offered the Forest Service for fine cooperation in the field and for making available much information and material; to Dr. E. R. Quortrup of the Fish and Wildlife Service for scat analyses; to the Patuxent Research Laboratory, Bowie, Maryland, for bone identification; to Dr. G. Dikmans, of the Bureau of Animal Industry, for parasite identification. Thanks are also given for helpful suggestions from O. J. Murie of the Fish and Wildlife Service, Jackson Hole, Wyoming, and to Dr. Hadleigh Marsh and Dr. Harlow Mills of Montana State College, Bozeman.

## II. EARLY HISTORY OF BIGHORNS AND THEIR EXTENT IN NORTH AMERICA

It is quite well agreed that mountain sheep, genus Ovis, had their origin in Asia, and that sometime during mid-Pleistocene time they began coming onto the North American continent. No sheep remains have been found in deposits earlier than this time. From this supposed land bridge across

the Bering Sea, sheep gradually spread southward along mountain chains for the length of the continent. The four or more glacial periods had a questionable effect upon the sheep populations, but must have been very instrumental in effecting their present distribution. For a treatment of Asiatic forms of Ovis, reference is made to Peter P. Sushkin, who has translated the works of Severtzov and Nassonov, Russian zoologists, and added notes of his own. For an excellent treatment of the distribution and variation of North American sheep, reference is made to the work of Cowan (1940). He has examined 761 specimens from points scattered across the continent and, using these as a basis, has listed the following ten geographic races of mountain sheep:

Ovis dalli dalli Nelson - the Dall sheep is found in the mountains of Alaska, the Yukon, and the Northwest Territories. It is white and the rams have slender, angular horns.

Ovis dalli kenaiensis Allen - Kenai sheep are found only on the Kenai Peninsula of Alaska. It is an isolated race but similar to the Dall sheep.

Ovis dalli stonei Allen - the Stone sheep is found in norther British Columbia. Its range does not overlap that of the Rocky Mountain bighorn. It is larger than the Dall sheep with similar horns, but very dark in color.

Ovis canadensis canadensis Shaw - the Canada bighorn or Rocky Mountain bighorn extends from mid-British Columbia to Colorado. It is noted for its very large head and horns.

Ovis canadensis auduboni Merriam - the Audubon sheep was found in the badlands areas adjoining the Missouri River in Montana, North Dakota and South Dakota. How much this species integrated with Ovis canadensis canadensis in Montana and Wyoming, is unknown due to lack of specimens from this area. The Audubon sheep is extinct but there are some who believe that this sheep should never have been distinguished from the Rocky Mountain bighorn.

Ovis canadensis californiana Douglas - the California bighorn was also called the Rimrock or Sierra bighorn and was found in the Cascades of Washington, Oregon, British Columbia, and the Sierra Nevada range of California. The only ones remaining are found in British Columbia.

Ovis canadensis nelsoni Merriam - the Nelson bighorn is found in western California and in the desert range of Nevada.

Ovis canadensis mexicana Merriam - the Mexican bighorn is found in the mountain ranges of Mexico, southern New Mexico and Arizona. Included in this group is the Arizona "Gaillardi" sheep.

Ovis canadensis cremnobates Elliot - this is the Peninsula bighorn of Lower California.

Ovis canadensis weemsi Goldman - the Weems bighorn is found in the southern part of Lower California, graduating northward into the cremnobates

subspecies.

III. HISTORY AND PRESENT DISTRIBUTION OF MONTANA BIGHORNS

Probably the first reference to bighorns in Montana is found in the Lewis and Clark journals. In describing bighorns near the mouth of the Marias River, Lewis writes: "These animals abound in this quarter, keeping themselves principally confined to the steep cliffs and bluffs of the river." (Thwaites Ed., Lewis, Vol. 5, pp. 229, July 29, 1806) Sheep were reported common in the Musselshell-Judith River areas on the Missouri. At about this same time Clark, who was going down the Yellowstone, describes "near Pompey's Tower saw 40 bighorns. Wanted to kill large buck but none were present." (Clark, July 25, 1806) Also, "at the junction of the Missouri and Yellowstone Rivers, I saw a large gang of ewes, yearlings and lambs and one ram. Shot the ram. We now have a ram, a ewe, and a yearling in the collection." (Clark, August 3, 1806).

Describing bighorns seen below the mouth of the Yellowstone, Lewis and Clark (May 25, 1805) say "the females bear young in early March. They have one or two young. They feed on grass but principally on the aromatic herbs which grow on the cliffs on inaccessible heights which they usually frequent. They select to lodge, cranies or crevices of rocks the faces of precipices where bear and wolf can not reach them. They bound from rock to rock and stand apparently in the most careless manner on the sides of precipices of many hundreds of feet. They are very shy and quick of both scent and sight."

In their notes on zoology, Lewis and Clark say the bighorn animal is found as low as the Beaver Bends, a few miles below the entrance of the Yellowstone River.

No mention is made of the bighorn when Lewis and Clark crossed the Rocky Mountains. They did find all big game scarce in this region. We do have references to bighorns in the Rockies at about that time. Bradbury (Thwaites Early Western Travels, Vol. 5, 1809-11) says, "Indian bows are short but strong. Those esteemed best are made from the horns of the animal called by the French 'gros corne'. This animal inhabits the Rocky Mountains and is gregarious. All who see it represent its agility in leaping from rock to rock as one of the most surprising things they have ever beheld. The Americans call it the mountain sheep, but probably it belongs to the genus antelope. The horns are exceedingly large for the size of the animal. The bows are made of three pieces, very neatly joined together by a long splice and wound with sinew."

Gabriel Franchere in his voyage to the Northwest Coast of America, (Thwaites Early Western Travels, Vol. 6, 1811-14) mentions this animal with great curved horns like a domestic sheep, as an inhabitant of the mountains.

Maximilian (Thwaites Early Western Travels, Vol. 22, 1832-34) mentions seeing bighorns near the mouth of the White Earth River (Muddy River). The farther up the river (Missouri) they traveled the more numerous bighorns became. They were most numerous in the area now included in Dawson,

Garfield and Valley Counties.

Hayden (1862) says "Southeast of the Black Hills (South Dakota) is this large badlands area (150-60 miles) along the White River composed of curious and weird formations. The mountain sheep, sometimes alone and sometimes in small bands, are seen on the tops of these towers, several hundred feet high and entirely inaccessible to the approach of man. Here they remain in security, rolling their large horns from side to side and casting suspicious glances at the traveller below. It is somewhat strange that this animal should prefer the most rugged and inaccessible places, where scarcely a spear of grass is seen, and no shrubs but here and there a solitary bunch of stunted sage. A few grassy spots like oases are found in this region, low down, at the base of the lofty towers and ridges, to which mountain sheep descend early in the morning to feed. Although the absence of vegetation in their favorite places of resort would induce the belief that they fared badly, yet when killed, they are invariably fat, and the meat is superior to that of domestic sheep. Water is very scarce here."

The same author describes the Crow area between the mouth of the Yellowstone River and the mountains, as the best game country in the world (buffalo, elk, deer, antelope, grizzly bear and mountain sheep).

From the above notes it seems apparent that bighorns were quite well distributed over the state, the Audubon sheep being found on the Yellowstone and Missouri Rivers and their tributaries wherein was found the rough, precipitous badlands type of terrain. It is probable that those sheep found at the headwaters of the Missouri were the Rocky Mountain bighorn (Ovis c. c.) and not the heavier jawed Audubon sheep. According to Mr. Albert Pulling, formerly in charge of the Fort Peck Refuge, the last Audubon sheep was killed in 1916 in the breaks country south of Glasgow, in Garfield County. The Snow Creek Game Preserve was created as a move to protect the bighorns but apparently it was too late.

Information is scant regarding numbers of sheep in the mountainous areas where they are now found, but occasional references by old-timers and from literature infer that bighorns were there in varying numbers. The Earl of Southesk (1859-60) describes hunting bighorns in the Embarrass River country in Saskatchewan. His description of the terrain and habitats of bighorn sheep are very similar to that of the present bighorn.

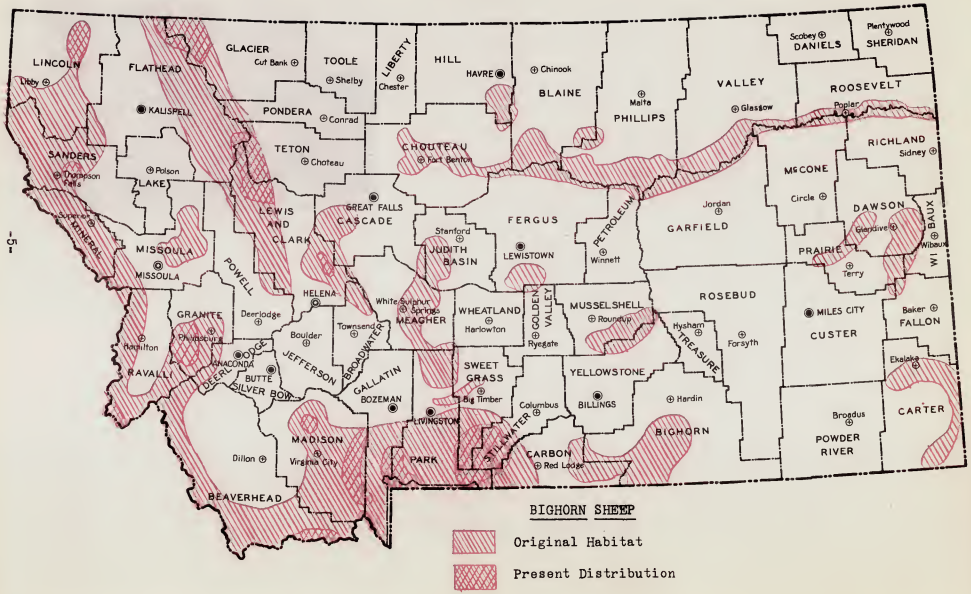
Bighorns were originally found over a much larger part of the state than they are now found. They disappeared from several places and have gradually dwindled down to the few small groups we now have. Map Number 1 shows this early day and present distribution of bighorns.

In 1830 and 1840 early fur explorers described sheep as numerous around Thompson Falls. The Bitterroot Valley also had many bighorns, but now they are practically extinct there. Old-timers at Missoula describe great losses of sheep near there from scab infestations.

The Red Rock Lakes-Cliff Lakes area in southern Madison and Beaverhead Counties at one time had great bands of bighorns and was noted as a hunting

Map 1.

# MONTANA.




BIGHORN SHEEP

Original Habitat

Present Distribution

area for these animals. Now there are a few isolated groups.

Bighorns were once plentiful in the Crazy Mountains but the last ones disappeared in the late 1920s. The same is true of the Snowy Mountains, Judith Mountains, Pryor Mountains, Little Rocky Mountains and the Bear Paw Mountains.

In the Big Belt Mountains sheep were once numerous, but the only ones present now are a few transplanted from the Sun River in 1943. They have scattered rather widely in these mountains since that time. In the hills to the north of this range, around Cascade, there used to be many bighorns. In the early 1880s there were reportedly great losses from scab infestations and sheep disappeared from this area shortly after this.

Sun River Herd. This is the group upon which the present study is being conducted. It was chosen for this because of its size and accessibility. There are about 275 sheep in the area, the bulk of them located north of the Sun River Canyon between the North Fork and the Forest boundary on the east. Included in this bunch are smaller groups located on Deep Creek, West Fork, Willow Creek, Scapegoat Mountain, and Steamboat Mountain, all of which may intermingle somewhat with the main group.

According to old residents there were probably more sheep here forty years ago than there are now, and their range varied somewhat within the area. The herd has been subject to several periodic die offs. There was a very severe die off in the winter of 1924-25 caused, as diagnosed by veterinarians in the field, by a verminous pneumonia. Since that time occasional sheep have been reported dying of a lung disease. Lung worms are very common in the herd at the present time.

Glacier Park Herd.

According to the Park Superintendent, there were 138 bighorns counted during the fall and winter of 1943, with an estimated total of 187 for the Park. The practice of feeding sheep has been discontinued and all concessionaire horses have been removed from the winter range in the Many Glaciers area. This type of management has relieved concentration of sheep in the winter and probably reduced the loss from disease, as, prior to this, there had been several winters with severe losses of bighorns in

Sun River Bighorns
Spring Mountain Winter Range

the Many Glaciers herd.

The population arose to about 300 bighorns in 1946 but the 1948 estimate by Park officials was 185.

Ural-Tweed Herd. These sheep are located on the east side of the Kootenai River between Warland and Sutton and range east as far as the Divide. There are approximately 125 sheep in this group, which is less than there were fifty years ago according to old-timers . The 1946 estimate for the Ural-Tweed sheep was 150 head. Lungworms are common as shown by fecal analysis.

Thompson Falls Herd. This herd, estimated at 25 sheep, is found on the east side of Thompson River near its mouth. Apparently sheep were found originally over much of the Cabinet Range. They have been seen recently around McGregor Lake, indicating a possible interchange with the Ural-Tweed band. Several old heads have been seen on Chippy Creek by Forest employees. In the primitive area east of Bull Lake (Scotty and Ibex Peaks) a few bighorn have been reported recently. According to old residents the present range on the Thompson River extended on both sides of the Clark's Fork of the Columbia River, over an area fifteen miles across. Now they are found in a four-mile area, restricted to the north side of the latter river and east of Thompson River. Lungworms are common in this herd.

West Fork of Bitterroot Herd. A small group of about 10 sheep have been observed on the Continental Divide, partly in Montana and partly in Idaho.

Rock Creek Herd. A group of 40 sheep is reported from the head of Rock Creek, southwest of Philipsburg. There were many more sheep here at one time.

Tobacco Root Mountains Herd. About 20 sheep are found wintering near Potosi Hot Springs. A collection of fecal samples from this herd showed, surprisingly, no lungworms--the only group in the state showing none.

Hilgard Herd. About 25 sheep were seen near Hebgen Dam in the spring of 1943 and some are known to winter there.

West Gallatin Herd. Some of this herd winters on West Fork and summers on the Spanish Peaks. Some are also found in the area at the head of Sage Creek. It is estimated that there are about 60 sheep in the Gallatin area. A few have been seen on the Gallatin Mountains north of Yellowstone Park.

Gardiner Herd. This herd is really the Yellowstone Park group that summers on Mt. Everts and vicinity. They do cross the river and a small number winter on the north side outside the Park, above the town of Gardiner. There are about 100 sheep in this band. Fecal samples show an abundance of lungworms.

Absaroka Range Sheep. There are several small groups in this area totaling about 225 head. A small group of about 10 winters on the East Rosebud River. On the West Rosebud River there are about 40 sheep that winter

Bighorn Winter Range
Stillwater River Near
Beartooth Ranch

Bighorns Near Mystic
Lake
West Rosebud River

Photo by Tom
Fostvedt
Caretaker--Mystic Lake

Bighorn Winter Range
West Rosebud River
Near Emerald Lake

between Emerald Lake and Mystic Lake. The power company caretaker at Mystic Lake has observed this group for eighteen years and its numbers have remained about the same. Fecal samples show lungworms to be very numerous.

On the Stillwater and Boulder Rivers of the Absaroka Range there is an estimated number of 175 sheep, the majority of which winter on the Stillwater River near the Mouat chrome mine. More may winter higher up on the wind-swept plateaus which are common and extensive in this range.

Mission Mountains Herd. A small band is reported on the Indian Reservation located on the north end of this mountain range.

Moiese Bison Range. About 12 bighorns are located on the Refuge.

Transplanted Areas. Fourteen bighorns were transplanted in the Gates of the Mountains area and they did not thrive too well. No accurate count has been made, but a few were reported by hunters in the area in 1948.

Sixteen bighorns from Colorado were released in the Missouri Breaks in Garfield County. There were 21 head there in 1948 and 32 head in 1949.

Six bighorns from the Sun River area were released on Wildhorse Island in Flathead Lake in 1947. There were a few sheep present from a previous plant and it is estimated that there are now around 21 head present.

This makes a total estimated population of about 1200 bighorns in the state.

## IV. THE SUN RIVER BIGHORN HERD

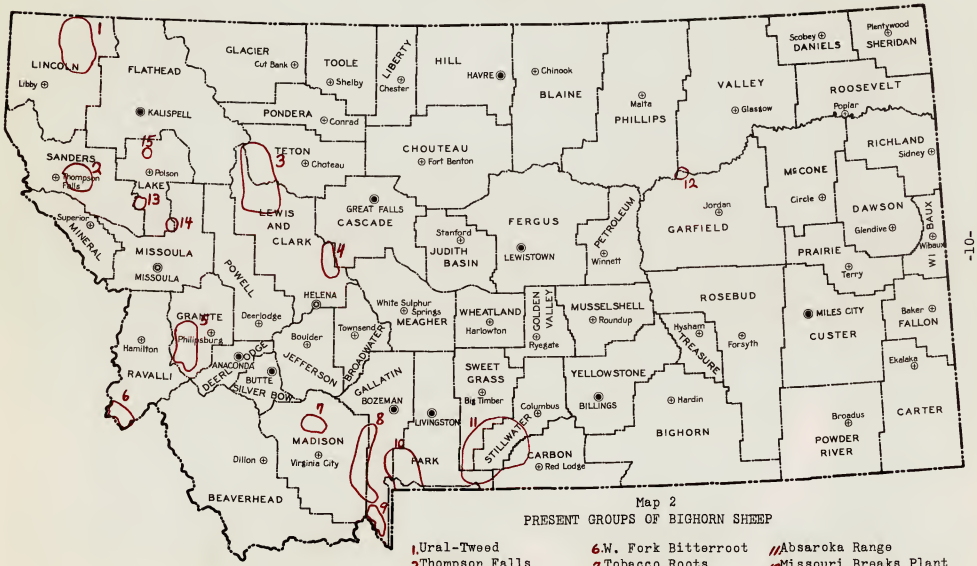
### Location and History

Apparently mountain sheep have always been found on the Sun River (see Map No. 2). Old-timers report sheep in varying numbers and varying localities as far back as 1866. Some report very large bands, and others say there were few more than today, but in general it is thought that they were more numerous than today.

Elers Koch (1940) describes: "the South Fork of the Flathead and Sun River country is today considered an excellent game country. Deer, elk and goats are relatively abundant, yet, in the fall of 1905 and again in 1906, I rode for a month with pack outfit through the wildest part of that country with a rifle on my saddle, and, with the exception of one goat, never saw or got a shot at a single big game animal, though grouse were fairly abundant."

Map No. 5 shows the winter range inhabited by bighorns in the Sun River region. They summer in the higher adjacent mountains where there is probably intermingling of the groups. Their winter range is for the most part on the north side of the Sun River and in the vicinity of the North and South Forks of the Sun River. Smaller groups winter on Deep Creek, West Fork, and Willow Creek.

# MONTANA.




Map 2
PRESENT GROUPS OF BIGHORN SHEEP

1. Ural-Tweed
2. Thompson Falls
3. Sun River
4. Gates of the Mtns.
5. Rock Creek
6. W. Fork Bitterroot
7. Tobacco Roots
8. Gallatin
9. Hilgard Mtns.
10. Yellowstone Park
11. Absaroka Range
12. Missouri Breaks Plant
13. Moiese
14. Mission Range
15. Wildhorse Island

Reliable observers report that in 1900 and 1910 sheep were never found on the Sun River below Big George Gulch. The number wintering on the Medicine Springs-Sheep Reef area compared to that of today. Other areas had sheep where they are not now found. These were Sawtooth Mountain, Straight Creek and Wood Creek.

Reports of phenomenally large bands of migrating sheep on occasion, from observers all over the state, lead one to think that there is something to this, although not to the extent that some would have one believe. Untrained people often have an exaggerated opinion of numbers of game when seen in groups. For instance, this observer has been present when a sportsman estimated 800 elk in a group that counted out 285. In spite of these exaggerations there have been reports by woodsmen and trappers who have seen bands of bighorns in this area numbering 150 and over, and apparently migrating. A group of 150 was reported between Ford and Willow Creeks in January, 1939. In the spring of 1908, on Headquarters Creek, tracks were seen where a large band had moved through, having the appearance of a domestic band. In 1910, a trapper reports seeing over 400 sheep crossing North Fork Flats near Sheep Reef. The author has never seen any sign of such banding, but workers in Wyoming have mentioned early day migrations of bighorns from winter to summer range over a distance of sixty miles.

Interviews with early residents also indicated that bighorns were subject to disease which periodically struck them, causing large die offs. Descriptions and causes of these maladies are varied and vague, but in general refer to a scab and a lung disease. The last major dieoff in this area was in the winter of 1924-25, when an estimated 70% of the bighorns were lost. Investigators in the field diagnosed the disease as verminous pneumonia. There have been reports of a recurrence of this disease in 1927 and again in 1936, when quite a few dead sheep were found. This disease has persisted to date.

Photo Through Binocular

Geology

That mountainous area between the North Fork and the South Fork of the Sun River and the plains is referred to geologically as the Sawtooth Range. It consists of a series of parallel reefs, running in a north and south direction with steep precipitous sides on the east, scattered timber-covered, westward dipping western sides. This characteristic formation makes toward an excellent

Lower Sun River
Canyon Showing
Narrow Slice
Faults or Reefs

game range as there is abundant but scattered forage which is kept fairly bare during winter by prevailing westerly winds. The abrupt cliffs to the east of these reefs form a barrier to most big game, causing them to seek certain passes or breaks when migrating.

The rocks of this area are largely Jefferson limestone, overlaid by Madison limestone and the later Kootenai and Colorado formations. These are sedimentary rocks that formed the bottoms of vast sea and lake beds, as evidenced by the numerous fossils (brachiopods, corals and bryozoans) found on the Sun River reef tops. In the closing stages of the Cretaceous period there came the great upheaval that formed this Rocky Mountain area, but it was much higher and much more rugged than it is now. Succeeding erosion and weathering during later Tertiary and Quaternary times, and especially the glacial action, reduced much of this to the lower peaks and valleys present now.

The great Lewis fault occurred along what is now the Continental Divide, which consisted in a slipping or thrusting from west to east of a great layer of the earth's crust. One of the most striking evidences of this fault is the escarpment known as the Chinese Wall. To the east of this fault, in the Sawtooth Range, there occurred long narrow folds which resulted in the closely-spaced thrust faults, or thin slices of faulted Paleozoic and Mesozoic rocks, found in the lower Sun River Canyon side drainages. Erosion, largely glacial, on these steeply westward-dipping rocks of the fault slices has produced a series of long narrow ridges 2,500 to 4,000 feet above the valleys separating them. The ruggedness of the higher points has been intensified by glacial action.

Most of the reef tops in the Sun River are composed of the youngest rocks of the area, being the Madison limestones of the Mississippian Period.

During the Pleistocene period of the Cenozoic era there occurred the

great glacial period during which time the upheaved mountains were gouged, valleys were scoured, peaks were plucked off by freezing and thawing action, and the resultant erosion by water action modified the formations, producing the ruggedness typical of this area.

There were at least four distinct glacial periods. The last, or late Wisconsin, covered this area. In the Sawtooth Range the glaciers gouged out V-shaped troughs or valleys as they flowed down toward lower elevations. The large rock for which Split-Rock Lake was named is a piece of Paleozoic limestone that was moved eight miles east of the mountains by glacier action.

Reef Type Looking Across Norwegian and French Gulches Toward Sawtooth Mountain

Topographical Features and Vegetative Types.

In game studies conducted by the Forest Service, much information was gathered concerning the range and vegetative cover of the Sun River game range. A report on the Sun River elk herd by Robert Cooney (1940) includes a description of this range, broken up into types according to their value as food or shelter for game. These types, with a brief description, are listed below. In general, the Sun River area may be considered about 75% timbered and 15% to 20% grass.

Mature Spruce, Alpine Fir Type.

This is found at high elevations (6,000-7,500 feet) on east and north slopes with undergrowth of rusty skunkbrush and a ground cover of beargrass. It is probably not used much by sheep but elk use it during summer and fall.

Mature Douglas Fir Type.

Found at 4,000-6,000 feet elevations and supporting a scattered growth of snowberry, rose, spirea, oregon grape, serviceberry and scattered weeds.

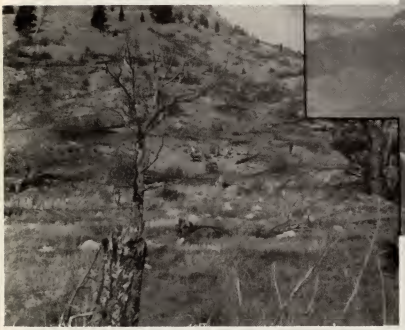
Ground cover is pinegrass, wheatgrass, poas and fescues. This type is used by game for shelter, but not a great deal of it remains as it has been largely burned over.

Limber Pine, Whitebark Pine, Reef Type.

The type is quite extensive and is found on the rocky, wind-swept sites at elevations between 5,500 and 8,500 feet. The trees are scattered, having a sparse understory of scrubby willow, mountain maple, snowberry and bearberry. Ground cover is composed primarily of widely scattered clumps of bunchgrass and weeds. This type is much used by bighorns all the year around. The exposed limestone rocks make an excellent protective background and, because these areas are wind-swept they are available all the year round, if for no more reason than acting as a pathway between areas.

Lodgepole Pine Type.

This type comes in following burns, and the age of the stand determines its value for game use. Young stands are usually so dense that they contain little forage. Mature lodgepole stands, which are extensive in parts of the Sun River area, support an understory of huckleberry, bearberry, nannyberry, oregon grape and a ground cover of pinegrass and lupine. Elk use this type during a large part of the year.



Non-restocked Burn Located Between Talus Slope and Grass Type Wagner Basin

Grassland Type
Sun River
Summer Range
Elk Hill

Burns - Non-restocking.

This is essentially a timber type and, although there is little timber now, it will eventually regenerate timber. These areas, which are very extensive in the lower Sun River, are composed of moderate stands of browse consisting of spirea, willow, mountain maple, rose, mockorange and snowberry. Pinegrass predominates with scattered bunchgrass, but at higher elevations beargrass comes in. Lack of cover makes this type of only moderate value for elk, but it is utilized quite extensively by mule deer. This type, where dead timber is standing, seems to be preferred by elk and is excellent summer range for bighorns.

Grassland Type.

The type makes up about 15% to 20% of the Sun River range. A large expanse of grassland is found on the North Fork Flats. Numerous smaller areas are scattered all over the Sun River range, even at alpine elevations. Elk in this area are largely grass eaters and get most of their food from this type. Bighorns also depend largely upon grass and obtain much of their forage from the edges of this type.

Aspen.

Small scattered groups of aspen are found all over the range up to an elevation of 6,500 feet. It is used little except as an emergency food for elk.

Brush Type.

This is a stringer type along streams consisting of alder, birch and willow, with here and there small birch and willow swamps. It is largely an emergency food type for elk and deer.

Climatic Conditions.

The number of animals that can survive in a game area is dependent, of course, on how much winter range is available. This is in turn determined by the amount of snow, its condition, and the accompanying temperatures. The amount of snow present is not as important as the condition of the snow. A heavy crust sometimes makes large areas of range unavailable. The degree of this crust, its duration, and the amount of snow, along with temperatures, determine the severity of the winter and can only be ascertained by direct observation of conditions. Therefore, snow depth readings are of little value in determining effect of snow conditions on game unless a great number of points of reading are established over the area to overcome extreme variations. The best way to determine the effects of winter on game is by field observations.

Meteorological data have been recorded at Gibson Dam since 1931. Table 1 shows the annual averages of these data. The higher than average precipitation during the period of this study explains the excellent condition of the range in this area. It can also be seen that during the two winters

Table 1

Mean Temperatures and Precipitation at Gibson Dam

| Year | Yearly Precip. | | Temperatures Mean | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | April | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | 54.3 | 81 | 82 | 65 | 59 | 39 | 37 | 32 | 44 | 34 | 52 | 61 | 69 |
| 1931 | | Min. | 31.7 | 47 | 45 | 40 | 35 | 23 | 21 | 18 | 22 | 20 | 31 | 37 | 43 |
| -32 | 14.50 | Mean | 42.9 | 64 | 63 | 55 | 47 | 31 | 29 | 20 | 33 | 27 | 42 | 49 | 56 |
| | | Max. | 52.8 | 81 | 75 | 70 | 53 | 46 | 29 | 34 | 28 | 44 | 49 | 57 | 70 |
| 1932 | | Min. | 31.5 | 46 | 46 | 37 | 32 | 29 | 17 | 24 | 19 | 24 | 30 | 34 | 42 |
| -33 | 17.54 | Mean | 42.1 | 64 | 60 | 54 | 42 | 38 | 23 | 29 | 24 | 34 | 39 | 46 | 56 |
| | | Max. | 57.3 | 78 | 76 | 63 | 57 | 50 | 38 | 43 | 44 | 47 | 60 | 67 | 67 |
| 1933 | | Min. | 33.0 | 47 | 44 | 37 | 32 | 30 | 22 | 25 | 24 | 24 | 32 | 39 | 41 |
| -34 | 21.86 | Mean | 45.5 | 62 | 60 | 50 | 45 | 40 | 30 | 34 | 34 | 36 | 46 | 58 | 54 |
| | | Max. | 51.5 | 79 | 56 | 62 | 60 | 41 | 36 | 36 | 41 | 38 | 43 | 58 | 68 |
| 1934 | | Min. | 30.2 | 45 | 41 | 36 | 36 | 31 | 23 | 16 | 22 | 22 | 20 | 33 | 41 |
| -35 | 11.77 | Mean | 40.4 | 62 | 49 | 49 | 48 | 40 | 30 | 21 | 33 | 30 | 32 | 41 | 55 |
| | | Max. | 53.8 | 81 | 78 | 70 | 56 | 40 | 40 | 33 | 16 | 37 | 53 | 70 | 73 |
| 1935 | | Min. | 28.0 | 45 | 43 | 38 | 40 | 22 | 21 | 13 | -15 | 19 | 27 | 38 | 45 |
| -36 | 11.27 | Mean | 41.3 | 63 | 66 | 54 | 48 | 31 | 31 | 23 | 1 | 28 | 40 | 54 | 59 |
| | | Max. | 54.8 | 88 | 81 | 69 | 59 | 48 | 34 | 15 | 32 | 41 | 53 | 69 | 69 |
| 1936 | | Min. | 27.7 | 48 | 45 | 39 | 33 | 23 | 17 | -9 | 9 | 19 | 30 | 36 | 41 |
| -37 | 10.63 | Mean | 41.0 | 68 | 63 | 54 | 46 | 35 | 26 | 3 | 20 | 30 | 41 | 50 | 55 |
| | | Max. | 53.6 | 84 | 78 | 69 | 58 | 41 | 35 | 36 | 32 | 41 | 53 | 58 | 69 |
| 1937 | | Min. | 30.1 | 47 | 44 | 38 | 37 | 23 | 17 | 18 | 7 | 23 | 30 | 36 | 43 |
| -38 | 19.97 | Mean | 42.3 | 65 | 61 | 53 | 48 | 32 | 26 | 27 | 19 | 32 | 41 | 47 | 56 |
| | | Max. | 53.5 | 76 | 75 | 74 | 57 | 37 | 35 | 37 | 28 | 44 | 56 | 63 | 63 |
| 1938 | | Min. | 30.1 | 48 | 44 | 40 | 33 | 22 | 18 | 24 | 8 | 20 | 30 | 37 | 39 |
| -39 | 13.16 | Mean | 37.7 | 62 | 59 | 57 | 45 | 30 | 26 | 30 | 18 | 32 | 43 | 50 | 51 |
| | | Max. | 57.4 | 84 | 83 | 70 | 56 | 53 | 43 | 32 | 35 | 44 | 49 | 67 | 74 |
| 1939 | | Min. | 31.9 | 48 | 44 | 39 | 35 | 30 | 27 | 11 | 15 | 27 | 29 | 38 | 42 |
| -40 | 10.74 | Mean | 44.7 | 66 | 63 | 54 | 45 | 41 | 35 | 21 | 25 | 36 | 39 | 52 | 58 |
| | | Max. | 57.0 | 81 | 83 | 70 | 58 | 37 | 40 | 40 | 41 | 48 | 55 | 64 | 69 |
| 1940 | | Min. | 30.6 | 46 | 43 | 43 | 36 | 15 | 22 | 18 | 15 | 21 | 28 | 37 | 43 |
| -41 | 18.33 | Mean | 43.7 | 64 | 63 | 56 | 47 | 26 | 31 | 29 | 28 | 34 | 42 | 50 | 56 |
| | | Max. | 53.3 | 79 | 77 | 59 | 56 | 47 | 36 | 36 | 33 | 43 | 56 | 57 | 62 |
| 1941 | | Min. | 28.4 | 48 | 44 | 35 | 29 | 26 | 18 | 13 | 10 | 21 | 28 | 37 | 43 |
| -42 | 24.45 | Mean | 41.0 | 63 | 60 | 47 | 42 | 37 | 27 | 24 | 21 | 32 | 42 | 45 | 50 |
| | | Max. | 52.7 | 78 | 77 | 66 | 58 | 39 | 37 | 26 | 41 | 37 | 57 | 56 | 61 |
| 1942 | | Min. | 26.3 | 44 | 42 | 37 | 32 | 20 | 19 | -1 | 18 | 9 | 30 | 31 | 37 |
| -43 | 24.45 | Mean | 39.3 | 61 | 60 | 52 | 45 | 29 | 28 | 12 | 29 | 23 | 43 | 43 | 49 |
| | | Max. | 54.3 | 78 | 78 | 72 | 61 | 48 | 40 | 40 | 34 | 37 | 54 | | |
| 1943 | | Min. | 27.6 | 43 | 43 | 37 | 33 | 25 | 19 | 19 | 13 | 15 | 30 | | |
| -44 | | Mean | 38.9 | 61 | 61 | 55 | 47 | 37 | 30 | 29 | 23 | 26 | 22 | | |
| | | Max. | 54.3 | | | | | | | | | | | | |
| | | Min. | 29.8 | | | | | | | | | | | | |
| Ave. | 16.46 | Mean | 41.6 | 63 | 60 | 53 | 46 | 34 | 28 | 23 | 24 | 30 | 40 | 49 | 50 |

or this investigational work, there have been two extremes--one of heavy precipitation, deep snow and low temperatures, and one of exceptionally light precipitation and mild temperatures, this latter affording a wide distribution of game. Average annual temperatures have been included but their importance as affecting game is questionable. This information is recorded fiscally (July 1 to July 1) rather than annually, to show the seasonal conditions.

Table 2 has been included showing the annual snow course readings by the U. S. Geological Survey. This stake is located on the north slope of Sheep Mountain. These readings show the comparative potential water run-off and of course show the comparative annual snow depths.

Table 2

Sheep Mountain Snow Course Readings

U. S. Geological Survey

| Date | Inches Snow | Inches Water |
|---|---|---|
| April 1, 1940 | 18.4 | 4.64 |
| Feb. 1, 1940 | 23.0 | 4.24 |
| Feb. 2, 1941 | 13.6 | 2.60 |
| Feb. 28, 1942 | 18.9 | 3.90 |
| March 31, 1942 | 23.9 | 5.60 |
| March 1, 1943 | 48.8 | 15.40 |
| April 1, 1943 | 52.3 | 15.40 |
| March 1, 1944 | 16.2 | 2.90 |
| April 1, 1944 | 25.5 | 5.50 |
| March 1, 1945 | 21.1 | 4.60 |
| April 1, 1945 | 27.8 | 6.60 |
| March 1, 1946 | 31.7 | 8.40 |
| April 1, 1946 | 32.5 | 9.90 |
| March 1947 | 49.2 | 16.10 |
| April 1947 | 45.3 | 17.80 |
| March 1, 1948 | 38.0 | 9.80 |
| April 1, 1948 | 44.3 | 11.70 |
| March 1, 1949 | 39.8 | 11.20 |
| April 1, 1949 | 42.6 | 13.40 |
| All-time average through 1948: | | |
| March | 29.5 | 7.80 |
| April | 30.6 | 8.90 |

Table 3

Classification of Winters

| | |
|---|---|
| 1915-16 | Average |
| 1916-17 | Very severe |
| 1917-18 | Severe |
| 1918-19 | Mild |
| 1919-20 | Very severe |
| 1920-21 | Average |
| 1921-22 | Very severe; bad crust |
| 1922-23 | Average |
| 1923-24 | Average |
| 1924-25 | Mild; heavy sheep loss |
| 1925-26 | Average |
| 1926-27 | Severe |
| 1927-28 | Very severe |
| 1928-29 | Mild |
| 1929-30 | Very severe; bad crust, heavy elk loss |
| 1930-31 | Average, early storms; heavy elk kill |
| 1931-32 | Mild |
| 1932-33 | Severe |
| 1933-34 | Average |
| 1934-35 | Mild |
| 1935-36 | Severe |
| 1936-37 | Average |
| 1937-38 | Average |
| 1938-39 | Average |
| 1939-40 | Mild |
| 1940-41 | Average |
| 1941-42 | Mild |
| 1942-43 | Severe |
| 1943-44 | Mild; open |
| 1944-45 | Mild |
| 1945-46 | Average |
| 1946-47 | Very severe; early ice, heavy snow, late spring |
| 1947-48 | Average |
| 1948-49 | Average; extreme cold |

Based upon the above data it would appear that severe conditions might be expected one out of three winters and mild conditions one out of four winters.

In order to present a history of winter conditions in this area, Table 3 was prepared. Winters are classified as mild, average, and severe in respect to their effect on game. This information was obtained from interviews of individuals, and from Forest Service records (largely from Robert Cooney's "Sun River Elk Study", 1940). According to this classification, one can expect every fourth winter to be mild and every third one to be severe.

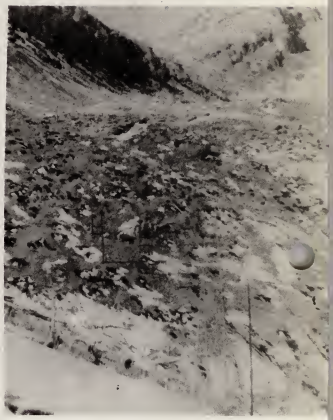
Reef Type
Looking North

The reef-type terrain, running north and south, and the prevailing northwest winds of the area are "lifesavers" for big game. The west slopes of the reefs are blown bare and afford a rather scant but sustaining amount of forage. This was exemplified during the winter of 1942-43 when there was possibly the heaviest snowfall on record, and it remained over a large part of the winter. Elk bunched up and migrated down river in mid-January at the time of the most severe storm. They were found at the mouths of Blacktail, Norwegian and Hannan Gulches for about three days, until the wind had partially bared the west slopes. After that the elk scattered all over these exposed areas and had little more difficulty in obtaining forage. There was not a loss above normal in this area--probably the only herd in the state that did not suffer severely. This scattering condition was observed on bighorns, too, but because of their smaller numbers was not so noticeable. In contrast to these wind-swept exposures the comparatively calm area in the North and South Forks may be cited. The heaviest loss of elk was in the lower Arsenic Creek to Scattering Springs area where there was little baring of the range and deep snow. Here also was noted the only direct evidence of competition between elk and bighorns.

Present Distribution and Numbers of Bighorns.

Through the continued and repeated coverages of the bighorn-inhabited areas, estimates were made as to the total numbers on these ranges. A census of Sun River bighorns in December 1941, conducted by Robert Cooney, showed an actual count of 161, and this included those on West Fork and Willow Creek. One hundred forty-nine of these were on Sun River. The following list shows the 1943 estimates of total sheep on the study area. Weather conditions did not permit another representative census.

| | |
|---|---|
| Sun River | 175 |
| West Fork | 25 |
| Willow Creek | 30 |
| Deep Creek | 30 |
| Scapegoat Mt. | 10 |
| Steamboat Mt. | 10 |
| Total | 280 |



Typical Bighorn Winter Range
Wagner Basin
Dark Patches are Bearberry

Sun River Group:

The winter range of this group is for the most part found along the north side of Sun River between Diversion Dam and Medicine Springs, varying in extent with the snow depth but, in general extending north along the reef tops and west slopes of the reef-type ridges. For convenience of study this area has been divided into units, as shown by Map 2. Approximately 50 sheep are found in the Castle Reef Unit, concentrating in Wagner Basin and on both sides of Castle Reef. The Home Gulch Unit includes French and Norwegian Gulches (all the range on the south side of the river) and it constitutes a lap-over of the Castle Reef group. It is used by occasional small wandering bands as well as a few ram groups that winter on top of the reefs there. Blacktail and Mortimer Units are used only occasionally by groups passing through. Big George, while presenting much good range, does not have over twenty wintering there. The rest of this herd and what is considered the main group is found in the Scattering Springs, Reclamation Flat and Sheep Reef units.

The West Fork group is found wintering on the reef near the large elk licks and extending west to the Allan Camp area. They also go north on the reef west of Pretty Prairie, with a small number drifting to the mountain between Goat Creek and the South Fork Gorge. They summer on the higher country adjacent to these ranges.

The Willow Creek group is found wintering on Ford and Fairview Mountains. They summer in the same general areas, extending their range northward as far as the Sheep Sheds on Allan Mountain and south to Cyanide Mountain.

According to reports from reliable sources, there are small groups of bighorns on both Steamboat and Scapegoat Mountains and west of Haystack Butte, but little is known of their condition or movements. They could quite easily contact the Willow Creek band.

The Deep Creek group is found on Erosion Creek on the South Fork, and on Slim, Billie and Sheep Gulches on the North Fork, wintering on the south slopes and summering on the very high adjacent mountains. The estimated thirty head for this area may be slightly conservative. Reports of sheep wintering on Ear Mountain and on Biggs Creek and on the South Fork of the Teton River, have not been confirmed. It is felt that there is considerable intermingling of these sheep with the Sun River group in summer, as the latter have been seen going into the country at the head of Cabin Creek and Grouse Creek.

Age Classes and Sex Ratio.

All sheep have been classified when possible as seen, according to sex and age. Table 4 shows this cumulative, running classification of all sheep seen during this investigation. The effect of certain factors should be noted when analyzing this table. For instance, the total per cent of males (42%) is somewhat lower than it should be because rams are not seen so frequently with the bands except during the breeding season, while ewe-lamb groups have been recorded quite often as observed, and this duplication causes the totals to be pulled in their direction. It is felt that with such large numbers of total sheep seen, the ewe, lamb and yearling relationship is very nearly correct. The per cent of lambs is a little too high. This was because more lambs than ewes wintered in the Reclamation Flat area (1942-43) and they

Winter Range in Big George Basin
Looking North Across Gibson Lake

Table 4

Sex and Age Classification
May 15, 1942 to May 1, 1944

| Location | Rams | 3 yr. Rams | 2 yr. Rams | 1 yr. Rams | 1 yr. Ewes | Uncl. Yrlg. | Ewes | Lambs | Total | Ewe-Lamb Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| Sheep Reef | 71 | 30 | 15 | 8 | 8 | 27 | 94 | 73 | 326 | .77 |
| Reclamation Flat | 144 | 28 | 41 | 23 | 32 | 68 | 437 | 242 | 1015 | .55 |
| Scattering Springs | 61 | 19 | 32 | 32 | 26 | - | 222 | 155 | 547 | .69 |
| West Fork | 10 | 3 | - | 1 | 3 | 6 | 35 | 18 | 76 | .51 |
| Big George | 28 | 10 | 9 | 6 | 9 | 12 | 122 | 61 | 257 | .55 |
| Mortimer | 2 | - | 1 | - | 2 | 1 | 13 | 6 | 25 | .46 |
| Castle Reef | 110 | 29 | 49 | 29 | 35 | 3 | 276 | 116 | 647 | .42 |
| Norwegian, French and Home Gulches | 15 | - | 3 | - | 1 | - | 9 | 10 | 38 | - |
| South Fk. Deep Creek | 9 | - | - | - | - | 2 | 15 | 10 | 36 | .67 |
| Willow Creek | 18 | 8 | 4 | 2 | 1 | 5 | 36 | 18 | 92 | .50 |
| Total | 468 | 127 | 154 | 101 | 117 | 124 | 1259 | 709 | 3059 | .56 |
| Per Cent | 15 | 4 | 5.5 | 3 | 3.5 | 4 | 41.5 | 23.5 | 100 | |

Males 42.3%  Females 57.7%  1 ram to 2.5 ewes

Table 5

Sex and Age Classification by Months

May 15, 1942 to May 1, 1944

| Month | Rams | 3 yr. Rams | 2 yr. Rams | 1 yr. Rams | 1 yr. Ewes | Yrlg. Uncl. | Ewes | Lambs | Total | Ewe-Lamb Ratio | Per Cent Yrlg. | Per Cent Lamb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| May 15-31 | 34 | 30 | 11 | - | - | 79 | 91 | 9 | 254 | .01 | 31 | - |
| June | 28 | 7 | 2 | 3 | - | 23 | 46 | 25 | 134 | .54 | 20 | 19 |
| July | 1 | 1 | 2 | 4 | 5 | 2 | 54 | 41 | 110 | .76 | 10 | 37 |
| August | 2 | 1 | 3 | - | - | 3 | 9 | 8 | 26 | .89 | 11 | 30 |
| September | - | 1 | - | 2 | 2 | - | 12 | 9 | 26 | .75 | 15 | 34 |
| October | 7 | - | 2 | 1 | 2 | - | 29 | 15 | 56 | .51 | 5 | 26 |
| November | 29 | 7 | 12 | 5 | 8 | 3 | 71 | 38 | 173 | .53 | 8 | 22 |
| December | 86 | 9 | 18 | 7 | 18 | 3 | 96 | 55 | 294 | .57 | 10 | 19 |
| January | 94 | 10 | 22 | 18 | 13 | 6 | 172 | 85 | 420 | .50 | 9 | 20 |
| February | 38 | 9 | 11 | 7 | 5 | - | 99 | 62 | 231 | .63 | 5 | 26 |
| March | 54 | 13 | 36 | 20 | 24 | - | 213 | 105 | 467 | .50 | 12 | 22 |
| April | 70 | 13 | 22 | 10 | 23 | 32 | 249 | 143 | 562 | .57 | 12 | 25 |
| May 1-15 | 24 | 2 | 11 | 3 | 3 | 6 | 89 | 50 | 188 | .56 | 7 | 26 |
| Total | 469 | 105 | 152 | 80 | 103 | 157 | 1230 | 645 | 2941 | .55 | 12 | 22 |

After May 15, all of the lambs of the preceding season have been considered yearlings.

Table 6

Unduplicated Bighorns Seen
During Winter of 1942-43

| Location | Rams | 3 yr. Rams | 2 yr. Rams | 1 yr. Rams | 1 yr. Ewes | Ewes | Lambs | Total |
|---|---|---|---|---|---|---|---|---|
| Wagner Basin | 6 | 2 | 3 | 3 | 2 | 17 | 7 | 40 |
| Home Gulch | 2 | - | 1 | - | - | 2 | 2 | 7 |
| Big George | - | 2 | - | - | 2 | 7 | 3 | 14 |
| Scattering Springs | 4 | 1 | 1 | - | 1 | 4 | 4 | 15 |
| Reclamation Flat | - | - | 1 | - | - | 6 | 10 | 17 |
| Sheep Reef | 4 | 1 | 2 | - | 1 | 2 | 3 | 13 |
| West Fork | 2 | - | - | 1 | 1 | 3 | 3 | 10 |
| Willow Creek | 4 | 4 | 1 | - | 1 | 5 | 4 | 19 |
| Total | 22 | 10 | 9 | 4 | 8 | 46 | 36 | 135 |

Males 47% Lambs 26% Yearlings 9%

Ewe-lamb ratio 1 to .78
Ewe-lamb (plus yearlings)
ratio 1 to .62

(These figures are affected somewhat by the group of lambs seen on Reclamation Flat)

were recorded quite often.

Table 5 shows this same cumulative, running classification according to months. This shows the seasonal change in numbers due to the breeding season, and the concentration on the winter range due to weather.

Both of these tables are based on incidence of occurrence and, in spite of the possible introduced errors, it is felt that, with the large numbers and extended over such a considerable length of time, this will come closer to a true picture of sex and age classes than any other method except actual count.

From Table 4 it can be seen that the per cent of males is 42% and the ratio of mature rams to ewes is 1 to 2.5. This does not seem excessive as far as rams are concerned. The severe mauling of ewes by rams described by Rush and Gammill in Yellowstone Park does not seem prevalent here.

From the figures of Table 5 it can be seen that there is a desirable percentage of lambs surviving their first year, but the number of yearlings surviving their second year seems low. The per cent of yearlings naturally decreases after their first birthday because the total figures are augmented by the new lambs coming in. According to Spencer (1943) in respect to the Tarryall herd of Colorado, there were counted in November, 147 ewes, 80 lambs and 44 yearlings. There are over half as many yearlings as lambs. The above tables show the proportion to be about one yearling to three lambs.

Ewe-lamb Ratio.

A popular method of determining the rate of increase in bighorn herds is by arriving at a ratio between ewes and lambs. These ewe-lamb figures are used because percentage figures for the whole herd would be quite inaccurate unless taken at the height of breeding when rams are present. This method is subject to several influencing factors. For instance, included in the ewe groups are old non-fertile ewes, young unbred ewes and possibly some yearlings, because the latter are sometimes difficult to classify.

Table 7 lists these ratios as determined by a number of invesigators on various bands of bighorns. For comparison these ratios are listed both with the yearlings included and with the yearlings excluded, because some of the workers classified the yearlings with the ewes. Note the comparison of the Sun River herd (Table 5) with the Tarryall herd. The lamb crop is about equal, but the yearling figures may show why the Tarryall herd is increasing faster than any other herd of bighorn.

It is assumed that twinning is not common in bighorns. No twins have been seen during this investigation and they are considered rare by other workers.

Table 8 shows the ewe-lamb ratios of bighorns seen by months during the entire two-year investigational period, with the hope of showing the yearly increase or decrease. Because of the extremely scattered condition of sheep population throughout the summer and fall months, only a few

unrepresentative figures were gotten for this period. There does seem to be a gradual decrease in lambs during the summer months, but they maintain their numbers throughout the winter. Survival through the two seasons is about the same.

Table 7

Ewe-Lamb Ratios

| Location | Ewes | Lambs | Ratio | Ewes plus Yearlings | Ratio |
|---|---|---|---|---|---|
| Yellowstone Park Mills (1937) | - | 33 | - | 66 | 1-.50 |
| Yellowstone Park Davis (1938) | 19 | 16 | 1-.84 | 26 | 1-.62 |
| Yellowstone Park Parsons (1935-36) | - | - | - | - | 1-.59 |
| Yellowstone Park Gammill- Ave. Mar. Counts | - | - | - | - | 1-.37 |
| Tarryall Herd, Colo. Spencer (1943) | 147 | 80 | 1-.54 | 191 | 1-.42 |
| Sun River (1944) Table 5 | 1230 | 645 | 1-.54 | 1570 | 1-.41 |
| Table 6 Sun River (1942-43) | 46 | 36 | 1-.78 | 58 | 1-.62 |
| Sun River Census (1941) | 81 | 29 | 1-.36 | 89 | 1-.33 |
| Average | | | 1-.64 | | 1-.51 |

An interesting sidelight in this respect is a theoretical projection, using a four-year old ram and a three-year old ewe to start with, and following through for ten years the offspring of these sheep. Assuming that rams do not breed until four and ewes until three years old, that the length of life of sheep is ten years, that there is no twinning, and that there is no loss from predators and disease, we find that at the end of ten years there are 13 ewes, 10 lambs, 7 yearlings and 9 rams. Averaging the ewes and lambs for the eighth, ninth and tenth years, we get a ewe-lamb ratio of 1-.77, which would seem to be the maximum possible. The average per cent of lambs for these years is 26% - for yearlings 18%.

It is felt that Table 6 shows a fairly accurate picture of the composition of the Sun River herd in 1943. These figures were obtained during February and March, when the snow was very deep and there was very little migration of bighorns. There was no duplication in the 135 sheep listed. Sheep on margins of units were not included. The ewe-lamb ratio of 1-.78 is indicative of an exceptionally good lamb crop. The low yearling count shows that there was either a scarcity of lambs the previous year or a succeeding loss of lambs. The figures from December 1941 census in Sun River show a very low lamb survival at that time and yearlings were very scarce in 1942. From this same table let us assume that there are as many two-year old ewes

Table 8

Monthly Ewe-lamb Ratios

| 1942-43 | Ewes | Lambs | Yearlings | Ewe-lamb Ratio | Ewe (plus yearling)-Lamb Ratio |
|---|---|---|---|---|---|
| June | 23 | 18 | 6 | .78 | .62 |
| July | 22 | 20 | 6 | .91 | .71 |
| August | 6 | 5 | 2 | .83 | .62 |
| September | 12 | 9 | 4 | .75 | .56 |
| October | 6 | 3 | 1 | .50 | .43 |
| November | 74 | 39 | 16 | .53 | .43 |
| December | 63 | 35 | 15 | .56 | .45 |
| January | 111 | 53 | 23 | .48 | .40 |
| February | 74 | 45 | 5 | .60 | .57 |
| March | 82 | 38 | 28 | .46 | .38 |
| April | 141 | 82 | 47 | .58 | .46 |
| May 1-15 | 89 | 50 | 12 | .55 | .50 |
| 1943-44 | | | | | |
| May 15-31 | 78 | 9 | 76 | .12 | - |
| June | 23 | 7 | 17 | .30 | .17 |
| July | 32 | 21 | 5 | .66 | .56 |
| August | 2 | 2 | 1 | 1.00 | .67 |
| September | - | - | - | - | - |
| October | 23 | 12 | 2 | .52 | .49 |
| November | 1 | 2 | - | - | - |
| December | 33 | 20 | 13 | .61 | .43 |
| January | 60 | 32 | 14 | .53 | .43 |
| February | 27 | 19 | 7 | .70 | .56 |
| March | 124 | 77 | 25 | .62 | .52 |
| April | 116 | 64 | 29 | .55 | .44 |
| May 1-15 | - | - | - | - | - |

as there are three-year old rams and that these ewes do not breed (we feel, however, that some do). Subtracting these ewes from the total number of ewes leaves 37 ewes to 36 lambs, approaching a 1-1 ratio. This looks like a good proportion of ewes are producing young. However, these figures may be somewhat affected by the fact that lambs separate sometimes at this time of year and the lamb count may have been too high in certain areas in respect to the ewes. This was true on Reclamation Flat where a group of lambs remained for two months, during mid-winter, with only an occasional visit of ewes.

## Life Habits

### Migrations on Summer and Winter Ranges.

There is a definite seasonal movement of bighorns onto winter range in fall and from it in the spring, but it is not considered a complete migration as some of the sheep remain all summer near winter range. The main influx of ewes occurs during latter October, just preceding the breeding season.

The rams separate from the others during the summer. They join the ewe-lamb groups again by mid-November. The breeding season peak is approximately December 1st, but it usually extends on until January 15th, after which the rams separate from the flocks again and bunch up on a reef top or some exclusive part of the range for the winter. Thirteen rams have been seen wintering in one bunch. The flocks of ewes, yearlings and lambs, with some young rams, are found on the lower winter range, moving quite often over an area three to five miles across. Thirty-four have been seen in one band, and as many as 63 have been reported seen.

During the winter of 1943 from February 1st to April 1st, a group of 18 lambs appeared on Spring Mountain. They never left the area and were visited only occasionally and briefly by a few adult ewes. This was not observed during the past winter, nor has any allusion to it appeared in literature. Possibly the heavy snow and rather severe competition of elk forced them to stay on this small mountain which was too steep for elk to climb. They fared quite well here and joined the other bands when they moved from the winter range in the spring.

Movements on the winter range seem to be an aimless wandering of the flocks from one part of the range to another. They have a number of bed grounds and usually head for one of these areas when night comes. These beds are scooped-out places on a gravelly ridge in which the sheep lie, using the same ones over and over. The beds are often ringed with droppings. During the early morning they feed, then they may take rest during midday, followed by another feeding period in the afternoon. This is especially true of the rams. The mixed flocks follow this pattern somewhat, but it is possible to find one or more sheep lying down at most any time of the day.

During the spring of 1943, 2 two-year old rams were caught in the trap located in the Scattering Springs unit, and the horns painted a bright orange. These rams were seen in this vicinity the succeeding fall and winter, showing

that they did not migrate to other areas. Several marked ewes (broken horns, etc.) have been observed repeatedly in certain areas, indicating little inter-unit movement. Rams do, however, move a great deal over the entire area during the breeding season. One ram with a crooked foot was seen to move nine miles in a day (from Scattering Springs to Wagner Basin). Following the breeding season, rams have also been seen far out on the prairie east of the foothills. Whether they were there in search of more ewes, better feed, or just following an instinct to migrate was not determined. This characteristic apparently insures a mixture of breeding stock among the small flocks.

Bighorn Summer Range
Head of Headquarters Creek

Spring migration occurs in late April and May prior to lambing. It is a gradual movement back to higher range and usually over regular routes. The rams appear with the ewes briefly, then go their separate ways toward the higher summer range. This mingling may be due to the fact that the rams in this area must cross the lower winter range to get to their summer range (winter range for rams is south of the river to a large extent). Ewes are usually heavy with lambs when the spring migration begins. They were found to seek steep precipitous places in which to lamb.

Mention has been made of sporadic migrations wherein large numbers of bighorns have been seen, presumably moving from one range area to another. It sounds fanciful, and as far as the author is aware, no one has ever reported finding sudden increases of population in any particular areas, but it has been heard so many times that there may be some truth in it. It is of interest in this regard to note that in the Wyoming Bighorn Study mention is made of large bands

Rams Migrating to Summer Range
Sheep Reef

The Two Rams in Center Are Fighting. The Rest of the Sheep Are Unconcerned

migrating annually in the early days when they were plentiful in that state.

Breeding Habits.

During the latter part of October the rams first appear with the ewes, wandering from flock to flock and inspecting them regularly to see if any are in oestrus (heat). This consists of a stalking walk with the head cocked to one side and nose outstretched, curling the upper lip and licking the nose rapidly. The ewes keep on grazing and such indifference sometimes provokes a vicious butt from a ram. Young rams have often been seen going through these antics all through the year. Actually, breeding probably does not take place before the 10th of November.

The spectacular "jousts" of the mature rams take place prior to breeding and seem to be a pre-mating activity. Several of these early season bouts have been observed and one can't help thinking that these rams are courteous and even gentlemanly in their trading of blows and head-on collisions. But after breeding has begun, these fights take on a more serious aspect. The tempo is speeded up; several rams may go at it in a free-for-all and the one that catches the other unawares is more often the winner. They sometimes injure one another. Mills (1938) mentions two cases of death from injury attributed to these fights. During the winter of 1943 a large thirteen-year old ram carcass was found. It had died earlier in the winter and one horn had been broken off, exposing the brain cavity. There were no cliffs near from which it might have been pushed or fallen, so the most logical explanation is that it died from a skull fracture as a result of a fight. Many of the older rams have been seen with large chips knocked from the front of their horns, and the tops of the horns worn down to blunt stubs.

A sheep head from Canada, mounted at the Roy Williams ranch in Carter County, Montana, has only a stub of a horn on one side, the broken surface being worn smooth. A ram with only one horn was reported in the Sun River area in 1941.

Only one ewe in a group is usually in oestrus at one time. When this occurs, a ram cuts her out from the flock and a great chase begins, usually with from five to seven more rams joining in. The oldest and largest ram tries to keep the younger ones away from the ewe and is not always successful.

Actual breeding takes only a few seconds and a ewe has been seen served by several different rams during one of these melees. Young ewes usually lead a faster and more spectacular chase than older ones. They scamper over rocks and through trees at a headlong pace, and when the ewe stops on a ledge or other point of security to rest, the rams stop and stand like statues. A group of six rams and a ewe were seen to stand thus for thirty minutes, not one as much as changing its position. Sometimes the ewe is urged to move by a vicious butt. A ewe in oestrus can hardly escape being bred.

The height of breeding season is during the last week of November, with a tapering off in December. The last actual breeding was seen January 4th, although there was interest shown by rams as late as mid-February.

Lambs.

The gestation period of bighorns has been described as lasting 180 days and this figure seems to apply here. The height of lambing is during the last week of May. First lambs were seen May 11th in both 1943 and 1944, and pregnant ewes have been seen on June 13th, so the period of lambing is about five weeks.

Ewe and Lamb - 7 to 10 Days Old
Spring Mountain
June 4, 1943

When a ewe is ready, she goes off by herself into a very steep, precipitous area and has her lamb. Twinning has not been observed. She remains here for a few days to a week, then joins with other sheep in flocks of from five to twelve or more, and they move on to higher summer range. A few of them are observed to remain on the winter range for one or two months. The lambs are very active, being able to run around and scamper over the rocks in two days. They are very playful when several are together. They are a mouse color with a dark streak down the middle of the back. They nurse frequently but only for short periods of time. The latest nursing date observed was October 21st. When a mother wants to go down to drink she caches the lamb or leaves it with some other ewes. This caching has been observed with very young lambs. A

ewe with a lamb appearing to be about a day old was seen on a ridge near some steep cliffs. The ewe left at the author's approach and walked slowly and unconcernedly away, but no lamb could be seen. Tracks showed where the lamb had gone to the steep rocks and the ewe left it, going in the opposite direction. Diligent search revealed no lamb, but the ewe remained within sight and kept looking concernedly toward the cliff.

Lambing Grounds
East Side Castle Reef

On June 7th, 2 ewes and 2 yearlings were seen in Wagner Basin at the trap after salt. One ewe acted strangely and emitted continuous guttural bleats. Thinking that she had a lamb nearby, the author retreated over a ridge and peeked back at them. The ewe immediately left, working her way up the talus slope to some precipitous rocks. When on these ledges she made louder sounds at about three-second intervals and was answered by the piping bleat of a lamb, soundirg similar to that of a domestic lamb. She did not go directly back to the lamb; seeing that it was unharmed, she returned to the salt. A careful search did not reveal the location of the lamb. It was certainly well hidden. This caching of lambs is apparently common and they depend upon their very good camouflaging coloration and their hiding ability to escape danger.

After they are ten to fourteen days old the lambs follow their mothers wherever they go. Near a salt ground on Spring Mountain, four ewes left their lambs with a fifth while they went down for salt. This guardian, noting the approach of an intruder, uttered a guttural warning noise which brought back the other ewes.

Voice.

The guttural warning sound is the only noise that has been heard from the ewes. The lambs make a bleating sound similar to that of domestic sheep but not nearly so frequently. The only sound detected from the rams was a snorting through the nose, made as a warning at the approach of apparent danger. This has also been heard when they stand together preparatory to a joust.

Coloration.

There is considerable seasonal as well as individual variation in color in bighorns. Shedding is a slow process, often lasting from May to July, during which time large mats of loose pelage may be seen, giving a bedraggled appearance which might mislead one into thinking they are in poor condition. When shedding is complete they are a brownish-gray color with a white rump. This color gradually fades with coming of winter until it becomes almost white by late winter. Occasionally one is found with a brown cast which it retains

all winter. These have made good markers during the study. Rams vary in color with age--old rams being darker with dark horns, while the young rams are light, getting quite white during winter, and having yellowish horns. Lambs and yearlings have longer hair about the head and neck, giving them a frowsy appearance that distinguishes them somewhat from the older sheep.

Senses.

Bighorns have a well-developed sense of sight, smell and hearing. Their sight is possibly better developed than other big game animals. From their vantage points on ridges or rim rocks they can see over large areas and can detect the slightest movement of a person approaching. A peculiarity of bighorns is their tendency to become alarmed when one is a great distance away but their apparent disregard of a person when he is quite near. This was observed many times and it was found that the best way to approach a band was to appear in plain sight below them and, keeping in sight of them, approach slowly in a quartering direction, never directly at them. In this way, one can work up to within thirty to fifty feet of them without alarm. If one approached from above, they would quickly stampede. A young ewe will many times alarm the entire band with a stomping of her feet. Mule deer will also alarm sheep as they are naturally more excitable, and when they are in the vicinity of sheep their flight will often cause the bighorns to run along with them. Lambs are instinctively more wary than older sheep. It is for this reason quite difficult to stalk or approach a group containing young lambs because they run first and look afterward, thus stampeding the whole group. The stiff-legged stomping of all four feet seems to be a warning gesture and has been observed in bighorns, mule deer and even occasionally in elk.

Leadership.

Ram groups usually have a definite leader when they are not with the ewes. During breeding season they seem to have no leadership, but wander from flock to flock, hunting for ewes. While it is often the strongest and presumably the oldest ram who wins out in their fights, they still do not try to lead the other rams and are being continually challenged.

Ewe bands also have recognized leaders, usually an old ewe. Fighting among ewes for leadership has been described by other workers but never observed here. However, ewes are commonly seen with broken horns; one was seen with one horn broken off flush with the skull. Almost every band has one or more with a broken tip of a horn. It is possible that fighting is the cause of this.

Use of Caves.

Throughout the range one can find caves that have received more or less use by bighorns. At the head of West Fork of Beaver Creek is a mountain named the Sheep Sheds because there are two caves there that were used by bighorns a number of years ago. They have not been used to any important extent recently. The floor of these caves is covered with about a foot of sheep manure in various stages of decomposition. Bighorns have been seen in this

Typical Bighorn
Winter Bedground

vicinity during the summer and it is thought that they may use the caves to get away from the heat. Other caves and protected places at bases of cliffs show use by sheep in escaping storms.

Forage Utilization.

Table 9

Principal Foods of Bighorns and Degree of Use

| Plant | Degree of Use |
|---|---|
| Festuca (fescues) | Heavy |
| Poa (bluegrasses) | Heavy |
| Agropyron (wheatgrasses) | Heavy, fall & winter |
| Koelaria (junegrass) | Moderate |
| Agrostis (red top) | Moderate |
| Stipa (needlegrass) | Little |
| Danthonia (oatgrass) | Little |
| Carex (sedges) | Little |
| Artemisia frigida (silver sage) | Heavy |
| Eurotia lanata (winterfat) | Moderate |
| Arctostaphylos (bearberry) | Moderate |
| Odostemon (oregon grape) | Light (roots taken too) |
| Ceanothus (snowbush) | Light |
| Symphoricarpos (snowbrush) | Light |
| Ribes (gooseberries and currants) | Light |
| Prunus demissa (chokecherry) | Light |
| Acer glabrum (mountain maple) | Light |
| Ledum (laborador-tea) | Moderate |
| Amelanchier (serviceberry) | Light |
| Rosa (rose) | Light |
| Pinus flexilus (limber pine) | Occasional |
| Pseudo-tsuga taxifolia (Douglas fir) | Little |
| Picea engelmanii (Engelman spruce) | Little (buds) |

From notes on actual observation, band trailing, analysis of forage

use around bedgrounds, and other heavily used areas, and from analysis of seven stomach samples, Table 9 was prepared showing the principal foods of bighorns and the degree of use. From this table it can be seen that there is a wide variety of foods taken but grass constitutes the bulk of food, consisting largely of the more palatable grasses and only the most choice parts of these. Various weeds are taken, particularly in the summer, but their use in winter is difficult to determine. Most of the reef-type browse plants are used slightly by bighorns but none of them seem to enter largely into their diet. Silver sage (Artemisia frigida) which is common all over the range seems to be a preferred food. The only definitely normal stomach sample examined contained 35% sage. This food is taken commonly in the winter as determined by muzzle marks in the snow. This plant is mentioned as a preferred food for badlands sheep, described by early explorers in eastern Montana.

When bighorns feed, it appears that they just nip the tips off of some plants or nuzzle for the very choicest bits of grass leaves. They will paw like elk in deep snow. They are always on the move, sometimes trotting 30 feet between bites. While they are occasionally found feeding in the heavy grass areas, by far the most of their time is spent on the margins of this type or on the comparatively protected rocky areas and talus slopes where forage is scant. The combination of plants on this type of terrain seems to represent the foods desired by bighorns. A typical section of this type may have a very low average density and consist of very scattered clumps of wheatgrass, occasional fescue and bluegrass, rather frequent mats of bearberry, clumps of snowbush in ravines, aster, penstemon, balsamroot, oregon grape, mockorange, mountain maple, chokecherry, serviceberry, and almost no timber other than some scrubby Douglas fir and limber pine. This type is inhabited by mule deer and, in emergencies, by elk.

Six stomach samples have been analyzed and the results are here described.

Ram, six to seven years old, found in Wagner Basin November 20, 1942, had eaten grass 97%, weeds and browse 3%, consisting of bearberry, ceanothus leaves and wild flax.

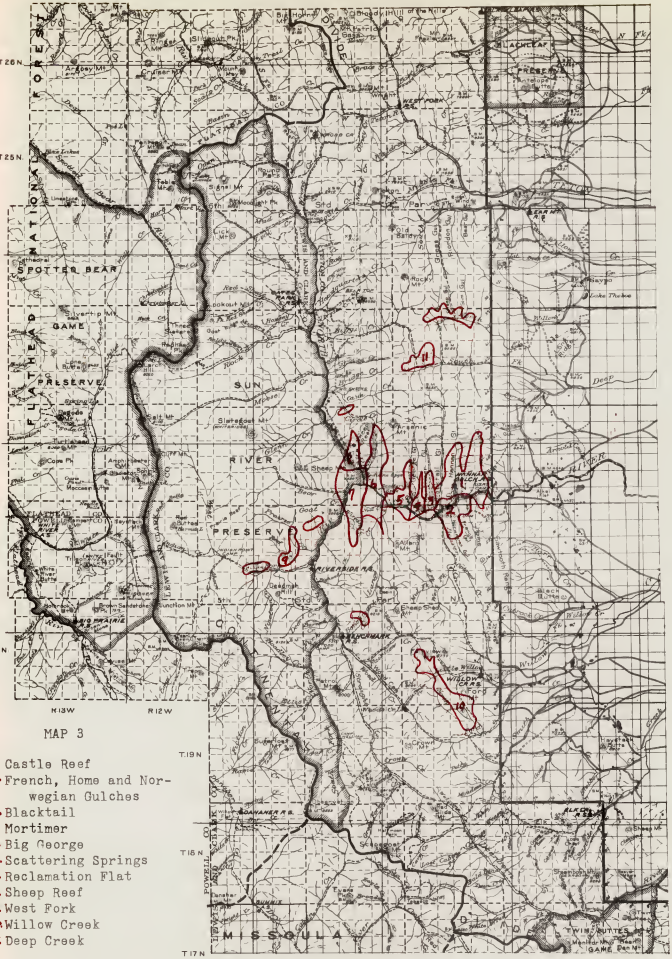
A mature ewe died accidentally in Wagner Basin November 26, 1942, and had eaten 35% silver sage, browse (unidentified twig tips) 30%, seeds (oregon grape?) 5%, and grass 30%.

A ram, twelve years old, found in Big George in January 1943, with one horn broken off and a skull fracture, had eaten grass (Agropyron) 95% and weeds 5%.

A very old ewe that died on Spring Mountain February 18, 1943, had eaten grass 30% and the remaining 70% was what appeared to be dry duff, composed of twigs, some soil, dry fir needles, bearberry leaves, sage and miscellaneous roots. Her teeth were very badly worn or missing, the jaw bones swollen twice normal size, and several teeth missing--the cavities packed with decayed food.

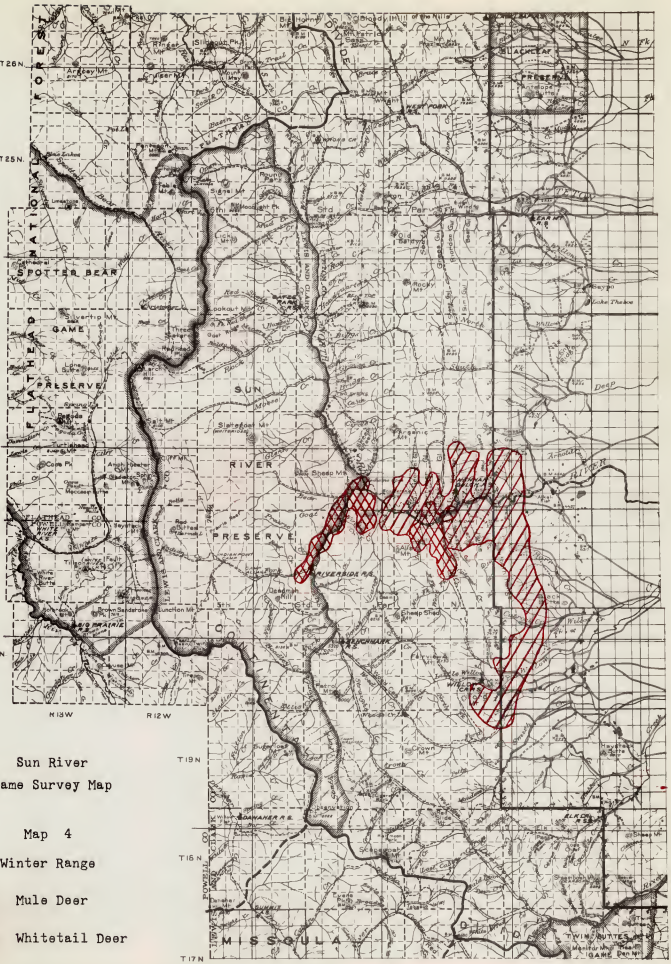
A ram, ten years old (one transplanted from the Gallatin River area

BIGHORN MOUNTAIN SHEEP WINTER RANGE BY UNITS




MAP 3

1. Castle Reef
2. French, Home and Norwegian Gulches
3. Blacktail
4. Mortimer
5. Big George
6. Scattering Springs
7. Reclamation Flat
8. Sheep Reef
9. West Fork
10. Willow Creek
11. Deep Creek



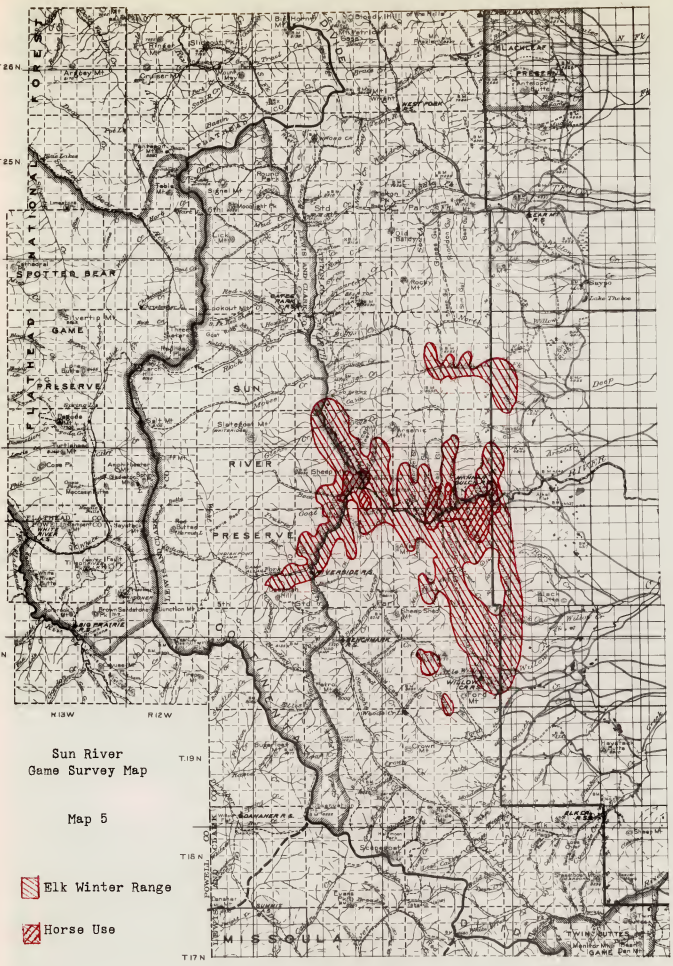

Sun River
Game Survey Map

Map 4

Winter Range

Mule Deer

Whitetail Deer




Sun River
Game Survey Map

Map 5

December 27, 1942) was found dead March 9, 1943, on Hannan Sheds. It had eaten grass 75%, unidentified browse and weeds 20%, bearberry 3%, and fir needles 2%. The teeth were badly worn and the lower jaws swollen abnormally.

A yearling ewe died January 29, 1944, in good flesh, probably from pneumonia, and had eaten grass 91%, browse 5% and miscellaneous material containing some moss-like plants.

As with four of these animals death may have resulted from disease or poor teeth, the foods taken may not be representative of normal bighorns. Roughly averaging these analyses, we find grass constituting 63%, browse 17%, weeds 14%, and miscellaneous 6%. From this and from observations, grass seems to constitute the bulk of food used on the winter range. The two animals that died in Wagner Basin in November 1942 represent two extremes--the ram eating 97% grass and the ewe eating 5% grass. It was thought that the ram died of pneumonia, which may have affected the diet in the latter stages, but the ewe died accidentally so had a normal stomach content. The other sheep may also have had abnormal diets, especially the old ewe from Spring Mountain that had apparently been eating duff.

Range Use and Description of Units.

Much could be written about the past use of the Sun River range by domestic stock, and the over-use this range received twenty and thirty years ago. This condition has been remedied so that there is relatively no competition now between game and stock on their winter range. This reduction of livestock, and favorable weather for the past several years has resulted in excellent range conditions throughout most of the area.

There is moderate use of certain portions of the winter range area by pack horse and cattle. To get an idea of total use, the Sun River area was divided into drainage units for convenience in study, and the total number of animal months, both stock and game, was estimated along with the monthly degree of utilization. This information is tabulated in the accompanying tables for the two winter seasons (1942-43 and 1943-44).

In respect to this range use, it may be well to point out here that the past two winters have represented two extremes in weather and in game distribution. The winter of 1942-43 was classed as severe and there was the heaviest snowfall in many years. Game was concentrated on lower Sun River in large numbers and the only reason there was not a large loss was because of this parallel reef-type formation that blows bare on the west slopes, exposing scattered forage. The winter of 1943-44 was mild, with not enough snow to force the elk from the game preserve until late winter and some of them not at all. Other game remained scattered over much of their summer range.

Castle Reef Unit.

This unit consists of Hannan Gulch, Wagner Basin (on the south end of the reef) and the area on the east side of the reef as far north as Green Timber Gulch. This latter portion is partially outside the Forest boundary

Talus Slope
Used Much By Bighorns
Wagner Basin

so has some cattle and horse use. The rest of the unit has only a little dude ranch use during the fall months. Table 10 shows the degree of use and the number of animals using the range by months. In the winter of 1942-43 the heavy use was largely due to the large numbers of elk and the limited amount of available range due to snow. The following winter shows little use for there were practically no elk there. Lack of snow caused no concentration of game, so estimates of numbers were difficult.

Of interest in this unit is the use Wagner Basin receives. This rather open basin covers about a section and is an important part of the bighorn range. It is covered on the lower part with a dense stand of bluebunch wheatgrass. The area is too conspicuous for much elk use because of lack of cover and the presence of human habitation. During the fall and winter of 1942-43 there were about 100 bighorn months, 240 mule deer months and 120 elk months use here and the total utilization by spring was not over 60%. Because snow in this basin melts quickly, most of the forage was available. Bighorns did most of their feeding on the loose rocky soil type where grass was scant as were the short browse plants and weeds. A picture post was established here showing range use monthly for a year.

Table 10

Range Use - Castle Reef Unit

| | Utilization | | Animal Months | | | |
|---|---|---|---|---|---|---|
| | | % | elk | bighorn | horse | deer |
| | 1942-43 | 10 | 25 | 30 | 10 | 150 |
| September | 1943-44 | - | - | 35 | - | 150 |
| | 1942-43 | 20 | 30 | 30 | 10 | 150 |
| October | 1943-44 | - | - | 35 | - | 150 |
| | 1942-43 | 30 | 75 | 50 | - | 250 |
| November | 1943-44 | 5 | 25 | 50 | - | 150 |
| | 1942-43 | 40 | 200 | 50 | - | 250 |
| December | 1943-44 | 5 | 25 | 50 | - | 250 |
| | 1942-43 | 55 | 150 | 50 | - | 250 |
| January | 1943-44 | 10 | 25 | 60 | - | 250 |
| | 1942-43 | 65 | 100 | 50 | - | 250 |
| February | 1943-44 | 20 | 25 | 60 | - | 250 |
| | 1942-43 | 70 | 100 | 50 | - | 250 |
| March | 1943-44 | 25 | 75 | 60 | - | 250 |
| | 1942-43 | 80 | 45 | 50 | - | 250 |
| April | 1943-44 | 30 | 75 | 50 | - | 250 |

Home, French and Norwegian Gulches.

Table 11

Range Use - Home, French and Norwegian Gulch Unit

| | Utilization | | Animal Months | | | |
|---|---|---|---|---|---|---|
| | | % | elk | bighorn | horse | deer |
| September | 1942-43 | 5 | - | - | 20 | 75 |
| | 1943-44 | 5 | - | - | 20 | 75 |
| October | 1942-43 | 15 | - | 5 | 30 | 50 |
| | 1943-44 | 15 | - | 5 | 30 | 50 |
| November | 1942-43 | 25 | - | 5 | 25 | 75 |
| | 1943-44 | 25 | - | 5 | 20 | 75 |
| December | 1942-43 | 30 | 5 | 5 | 5 | 75 |
| | 1943-44 | 25 | - | 5 | 15 | 75 |
| January | 1942-43 | 45 | 50 | 10 | - | 100 |
| | 1943-44 | 30 | - | 5 | 5 | 75 |
| February | 1942-43 | 60 | 125 | 10 | - | 125 |
| | 1943-44 | 30 | - | 5 | - | 75 |
| March | 1942-43 | 75 | 100 | 10 | - | 125 |
| | 1943-44 | 35 | - | 5 | - | 75 |
| April | 1942-43 | 80 | 50 | 10 | - | 100 |
| | 1943-44 | 40 | - | 5 | - | 75 |

This is not very important bighorn range, but is used somewhat by sheep crossing over from the Castle Reef unit. Rams winter on the two reefs between Norwegian and Home Gulches. A few itinerant bands are found occasionally during winter on the talus slope near the Klick ranch, on the grassy hills to the east of Klick's and a few on the west slope of Diversion Dam Reef. While Home Gulch is subjected to quite heavy horse use, it is felt that little of this range is common to bighorn and horse. Just across the river is Wagner Basin with an abundance of forage.

Blacktail Gulch.

This is not very important bighorn range. The drainage is largely timbered with fir and lodgepole, with an abundance of browse plants, making excellent summer range for mule deer and elk. The lower three miles of the drainage is subjected to horse use from dude ranches--about twenty-five head are there for two to three months.

Sheep are found wintering on the south ends of the two reefs at the mouth of the gulch. They are not found in large numbers and probably use it mostly in passing through. No bighorns have been observed staying in this unit for any long periods of time.

In January 1943, the big storm forced a herd of about 125 elk down to the mouth of the gulch. They remained about two weeks and cleaned up all the available food, after which they dispersed up Beaver Creek and into Mortimer and Big George Gulches. It looked like there was direct competition

with the white-tail deer here because, later, large numbers of these deer died around the mouth of Beaver Creek, Norwegian and Blacktail Gulches, and Mortimer Gulch.

Table 12

Range Use - Lower Blacktail Unit

| | Utilization | | Animal Months | | | | |
|---|---|---|---|---|---|---|---|
| | | % | elk | bighorn | horse | deer | |
| | 1942-43 | 60 | 5 | 5 | - | 50 | (summer) |
| September | 1943-44 | 50 | - | - | - | 50 | " |
| | 1942-43 | 70 | - | 5 | - | 50 | |
| October | 1943-44 | 50 | - | 5 | - | 30 | |
| | 1942-43 | 80 | - | 7 | - | 75 | |
| November | 1943-44 | 50 | - | 5 | - | 100 | |
| | 1942-43 | 80 | - | 5 | - | 100 | |
| December | 1943-44 | 50 | - | 5 | - | 100 | |
| | 1942-43 | 80 | 30 | 5 | - | 150 | |
| January | 1943-44 | 60 | - | 5 | - | 100 | |
| | 1942-43 | 80 | 40 | 5 | - | 150 | |
| February | 1943-44 | 60 | - | 5 | - | 100 | |
| | 1942-43 | 85 | 10 | 5 | - | 150 | |
| March | 1943-44 | 60 | 5 | 5 | - | 100 | |
| | 1942-43 | 85 | 25 | 5 | - | 150 | |
| April | 1943-44 | 60 | 5 | 5 | - | 100 | |

Mortimer Gulch.

This valley is not used much by bighorns except in passing through. They are found on the bare rocky east side and a few winter on the lower

Table 13

Range Use - Mortimer Unit

| | Utilization | | Animal Months | | | |
|---|---|---|---|---|---|---|
| | | % | elk | bighorn | horse | deer |
| | 1942-43 | 25 | 30 | - | 15 | 100 |
| September | 1943-44 | 20 | 5 | - | 15 | 100 |
| | 1942-43 | 35 | 15 | - | 10 | 50 |
| October | 1943-44 | 20 | - | 5 | 15 | 75 |
| | 1942-43 | 45 | 25 | 5 | 10 | 100 |
| November | 1943-44 | 25 | - | 5 | 10 | 75 |
| | 1942-43 | 55 | 75 | 5 | - | 150 |
| December | 1943-44 | 25 | - | 5 | 5 | 100 |
| | 1942-43 | 70 | 30 | 5 | - | 150 |
| January | 1943-44 | 25 | - | 5 | - | 100 |
| | 1942-43 | 75 | 30 | 10 | - | 150 |
| February | 1943-44 | 30 | 15 | 5 | - | 100 |
| | 1942-43 | 80 | 60 | 10 | - | 150 |
| March | 1943-44 | 35 | 20 | 5 | - | 100 |
| | 1942-43 | 85 | 60 | 10 | - | 150 |
| April | 1943-44 | 40 | 30 | 5 | - | 100 |

west side which is a more typical sheep type. The main unit has scattered areas of timber (mostly fir with some lodgepole and numerous aspen clumps) and grassy hillsides, making excellent deer and elk range.

About fifteen head of horses spend part of the summer here. A few elk summer at the head of the gulch. The unit is used normally throughout early and late winter months as an elk migration route from Big George to Beaver Creek. It gets heavy use in spring as its bare hillsides green up quite early. During the winter of 1942-43 it had heavy use by elk and deer. An unusually large number of white-tail died here in late winter. In the following winter there was no elk use and scattered deer use.

Big George.

Table 14

Range Use - Big George Unit

| | Utilization | | Animal Months | | | |
|---|---|---|---|---|---|---|
| | | % | elk | bighorn | horse | deer |
| | 1942-43 | - | 100 | 15 | 12 | 200 |
| September | 1943-44 | - | 15 | 15 | 5 | 200 |
| | 1942-43 | - | 50 | 15 | - | 200 |
| October | 1943-44 | - | 5 | 15 | - | 200 |
| | 1942-43 | 15 | 10 | 15 | - | 200 |
| November | 1943-44 | - | - | 15 | - | 150 |
| | 1942-43 | 40 | 100 | 15 | - | 300 |
| December | 1943-44 | 10 | - | 15 | - | 200 |
| | 1942-43 | 50 | 75 | 15 | - | 300 |
| January | 1943-44 | 15 | 100 | 15 | - | 200 |
| | 1942-43 | 60 | 100 | 25 | - | 300 |
| February | 1943-44 | 20 | 25 | 15 | - | 200 |
| | 1942-43 | 80 | 200 | 25 | - | 300 |
| March | 1943-44 | 30 | 30 | 15 | - | 200 |
| | 1942-43 | 85 | 200 | 25 | - | 300 |
| April | 1943-44 | 40 | 75 | 25 | - | 200 |

This drainage represents excellent big game range. It is wider than the other gulches, with large patches of fir on north slopes, clumps of aspen, and large areas of grass. An extensive south exposure of grass-covered hills faces the lake and is ordinarily used by both mule deer and elk. Bighorns are found on the south ends of the reefs on both sides of this unit, furnishing range for many more sheep than are found here. Probably not more than twenty-five sheep use the unit. The east side of Big George on the lower end is steep and rocky, quite extensive, with sparse vegetation and is favored by sheep. The tops of the ridges on the lower west side of the gulch are also used considerably by sheep.

According to the best information available, bighorns were not found in the Sun River below Big George Gulch in early days. This may have been due to the hunting pressure at that time.

The winter of 1942-43 concentrated overly large numbers of elk and mule deer on Lower Big George. There was over-use in many places, and quite a few elk died, for the most part calves or old elk.

In 1943-44 there were not over thirty elk in the entire gulch at the beginning of hunting season, nor did any move in until March, when about seventy-five gradually came in from Arsenic Creek.

Scattering Springs.

This is a small but important unit as far as bighorns are concerned. It is largely critical winter range on which sheep may be seen at almost any time during winter and usually through much of the summer. It is predominantly grassland with occasional clumps of aspen and fir, and is bordered on the north by a heavy fir belt. Included in the unit are several ridges to the north that drain into Arsenic Creek. The main south-exposed hillsides are covered with wheatgrass, fescue and poa, while the dense, grassy flats are fescue, poa, wheatgrass, brome, timothy and giant ryegrass. On the west side is Elbow Mountain, which has steep, rocky ledges covered with bunchgrass and on which sheep are most frequently seen. On the east side is the very high Scattering Springs Reef which extends south from Arsenic Peak and on which some of the sheep summer. It is covered with scrub fir, maple, mock-orange, snowbush, rose, gooseberry, labrador-tea and scattered bunchgrass, but all this is scattered and much is bare rock, making a good bighorn type. A picture post was established on the flats, and a series of monthly pictures was taken showing range conditions over a year.

Table 15

Range Use - Scattering Springs Unit

| | Utilization | | Animal Months | | | |
|---|---|---|---|---|---|---|
| | | % | elk | bighorn | horse | deer |
| September | | | | | | |
| | 1942-43 | - | - | 25 | - | 10 |
| October | 1943-44 | - | - | 25 | - | 10 |
| | 1942-43 | 40 | 20 | 25 | - | 25 |
| November | 1943-44 | 10 | - | 25 | - | 25 |
| | 1942-43 | 60 | 50 | 20 | - | 25 |
| December | 1943-44 | 10 | - | 25 | - | 25 |
| | 1942-43 | 75 | 100 | 25 | - | 5 |
| January | 1943-44 | 15 | - | 25 | - | - |
| | 1942-43 | 80 | 30 | 25 | - | - |
| February | 1943-44 | 15 | 5 | 25 | - | - |
| | 1942-43 | 85 | 75 | 25 | - | - |
| March | 1943-44 | 25 | 40 | 30 | - | - |
| | 1942-43 | 90 | 30 | 25 | - | - |
| April | 1943-44 | 40 | 60 | 30 | - | 5 |

During the summer months game use this area but little, other than a few mule deer and occasional groups of sheep. Pack horses use it lightly in

Brush Type
Scattering Springs

the fall during hunting season.

A trap has been constructed on the flats for catching bighorns for marking and transplanting purposes. It was baited with salt and attracted all big game.

During the winter this unit is quite heavily used by elk. As soon as hunting season closes they move in from Arsenic Creek and remain in the vicinity until green grass has come. During the winter of 1943-44 about twenty-five sheep used it for most of the winter, but no elk appeared until March 1st.

Reclamation Flat.

This unit adjoins Scattering Springs to the west and is bounded on the north by Arsenic Creek and includes Spring Mountain, Sun Butte, Black Reef and the area between there and Lang Creek. It is important bighorn winter range.

Table 16

Range Use - Reclamation Flat Unit

| | Utilization | | Animal Months | | | |
|---|---|---|---|---|---|---|
| | | % | elk | bighorn | horse | deer |
| | 1942-43 | - | - | 10 | 30 | - |
| September | 1943-44 | - | - | 10 | 30 | - |
| | 1942-43 | 10 | - | 25 | 50 | - |
| October | 1943-44 | 15 | - | 30 | 50 | - |
| | 1942-43 | 15 | - | 30 | 50 | 50 |
| November | 1943-44 | 15 | - | 20 | 50 | 50 |
| | 1942-43 | 60 | 175 | 35 | - | 75 |
| December | 1943-44 | 15 | - | 20 | 15 | 50 |
| | 1942-43 | 77 | 125 | 35 | - | 75 |
| January | 1943-44 | 20 | 10 | 20 | 5 | 50 |
| | 1942-43 | 80 | 30 | 30 | - | 75 |
| February | 1943-44 | 30 | 15 | 25 | - | 75 |
| | 1942-43 | 85 | 35 | 25 | - | 75 |
| March | 1943-44 | 60 | 75 | 30 | - | 75 |
| | 1942-43 | 90 | 30 | 25 | - | 50 |
| April | 1943-44 | 65 | 25 | 30 | - | 50 |

It is largely grassland similar to the above unit with clumps of fir, lodgepole and aspen. Spring Mountain is like Elbow Mountain with grass-covered ledges and steep rocks for protection and considerable feed available only

The winter of 1942-43 was severe and the pictures show heavy elk use. Range in background is favored by Bighorns.

August 1, 1942

September 1, 1942

November 1, 1942

December 15, 1942

February 1, 1943

April 15, 1943

Ewe at Salt Ground
Reclamation Flat

to bighorns. Sheep may be seen on this mountain any month of the year. Sun Butte is similar to Spring Mountain and is used much by sheep. Black Reef is used somewhat in the fall but mostly by rams wintering on top and on the south end.

This area receives considerable use by pack and saddle stock. Dude ranches and hunting camps are operating in the area from June to December. The bulk of this horse use occurs on Bear Creek, Furman Creek and Arsenic Creek. These are not entirely included on sheep winter range, but they are on elk winter range. This amounts to about twenty-five horses per month during the summer and about fifty during latter September, October and November.

A picture point was established on the flats from which monthly pictures of the range (close-up with the main range in the background) were taken for a year, showing seasonal use.

In 1942, elk moved in immediately after hunting season, which was December 5th. The deep snow in the upper country caused this, and as a result the range was heavily used quite early in the winter. A mild February, during which many ridges became bare, gave some respite and many elk migrated down river. March was severe, with cold weather and crust on the snow. The sheep did not seem to suffer but quite a few elk died, especially calves and old cows. The loss was not felt to be above normal, considering the herd as a whole.

While little direct effect of competition between elk and bighorn could be seen, there must have been some because elk were found on almost every part of the range, even on some of the ledges of Spring Mountain. The sheep

Spring Mountain
Typical Bighorn Range

never appeared in poor condition so there is room for more of this species here even under critical conditions.

Sheep Reef.

This unit includes only the ridge itself on the north, but expands to the south to include the two lesser groups of rock outcrop and the grassy area just north of Klick's upper camp. The reef is slightly precipitous to the east but the west slopes sharply downward toward the North Fork Flats. This slope is composed of smooth rocks crisscrossed with grass-covered ledges. The adjoining grassy areas on the flats are heavily used by elk but, as sheep are seldom found there, they have not been included in this unit. The dark-colored gabbroidal rocks of this reef contrast sharply with the surrounding light-colored limestone reefs. The top of the reef is narrow, covered with scattered fir and changing to lodgepole at the north end.

As its name implies, this has long been winter range for bighorns. They work down from their summer range on Cabin, Grouse and Biggs Creeks by way of the Circle Creek Gorge. There is a pronounced movement between this reef and the Reclamation Flat and Scattering Springs units during the winter.

Table 17

Range Use - Sheep Reef Unit

| | Utilization | | Animal Months | | | |
|---|---|---|---|---|---|---|
| | | % | elk | bighorn | horse | deer |
| | 1942-43 | 5 | - | - | 5 | - |
| September | 1943-44 | - | - | - | - | - |
| | 1942-43 | 15 | 10 | 13 | 5 | - |
| October | 1943-44 | 5 | - | 20 | 5 | - |
| | 1942-43 | 25 | 25 | 25 | 5 | - |
| November | 1943-44 | 5 | - | 25 | 5 | - |
| | 1942-43 | 35 | 50 | 25 | - | - |
| December | 1943-44 | 10 | 5 | 25 | - | - |
| | 1942-43 | 45 | 35 | 25 | - | - |
| January | 1943-44 | 20 | 25 | 25 | - | - |
| | 1942-43 | 60 | 30 | 25 | - | - |
| February | 1943-44 | 30 | 50 | 25 | - | - |
| | 1942-43 | 80 | 30 | 25 | - | - |
| March | 1943-44 | 50 | 50 | 25 | - | - |
| | 1942-43 | 85 | 25 | 25 | - | - |
| April | 1943-44 | 65 | 75 | 25 | - | - |

Elk use the area quite heavily on the Arsenic Creek side, and there is some use all over the reef. During the winter of 1942-43, the elk used this reef and that part of the unit on Arsenic Creek was used heavily. During the winter of 1943-44 there was only moderate use as there was little snow.

West Fork

This area includes the rocky reef just east of the West Fork Licks,

the reef west of Pretty Prairie, and the mountain west of the South Fork Gorge just south of Goat Creek. A few sheep are found on West Fork as far as the Allan Camp. The lick which attracts elk has caused a deteriorated range condition. There seems to be direct competition between the elk and the sheep and possibly the size of this little bighorn group is governed by the amount of forage on the steep rocky ledges inaccessible to elk.

West Fork Licks
Used Heavily by Elk
and Occasionally by Bighorn

Willow Creek.

The winter range of this group of sheep is on the south ends of Fairview Mountain and Ford Mountain, with some movement between the two. This high range is used by cattle for three months of the year. During the past two seasons there has been an abundance of grass on the winter range. Elk are not found much on Ford Mountain, but a few usually winter on Fairview Plateau.

Deep Creek.

Both the North and South Forks of Deep Creek have an abundance of range that appears suitable for bighorn, but there are not a large number there at the present time. The north slopes of these drainages are heavily timbered and the south slopes are burned over with rather extensive grass areas. Cattle use these creeks for three months during the summer. The heaviest use by cattle is on Erosion Creek (38 head). There were 129 head of cattle on the North Fork scattered on Billie, Slim and Sheep Gulches and the head of the North Fork. Mountain sheep winter on the south ends of the reefs between Slim, Sheep and Billie Gulches, and on Erosion Creek near its mouth on the South Fork of Deep Creek.

Bighorn Winter Range
in Background
West Fork Licks

Ram With Horn Broken Off, Presumably
Caused by Fighting.
From Big George Gulch

PARASITES AND DISEASE.

Dead Bighorns Found.

On November 20, 1942, a seven-year old ram was found in Wagner Basin. Cause of death was unknown. It had been dead for several days and birds had torn up the viscera so much that little could be told regarding their condition. There was a bloody discharge from the nose. No bullet holes could be found.

November 26, 1942, a ewe was killed accidentally in the trap at Wagner Basin during trapping and transplanting work. Whether death was caused by fright, shock or mechanical injury could not be definitely determined. No abnormal pathological condition was found other than an occasional small yellow spot on the distal portions of the diaphragmatic lobe of the lung. These spots showed, upon microscopical examination, numerous lungworm ova and larvae. Several adult lungworm (Protostrongylus rushi) were found in the bronchioles. In the bile duct was found a tapeworm resembling the fringed tapeworm (Thysanosoma actinoides). In the abomasum (fourth stomach) were found two species of nematodes with their anterior ends embedded in the mucosa. They were identified by Dikmans (Beltsville, Md.) as Ostertagia marshalli and O. occidentalis. Another nematode from the small intestine was likewise identified as Nematodirus sp.

An adult ram thirteen years old that died in January was found in March, 1943. This ram had one horn broken off, exposing the brain. The most logical explanation of death appears to be that the injury occurred while fighting. There were no signs of bullet marks nor were there any steep cliffs nearby from which it may have fallen. The carcass was destroyed by coyotes. Teeth were badly worn.

February 18, 1943, a very old ewe died on Spring Mountain. She was almost eaten up by coyotes when discovered. The teeth were in bad shape, several molars missing and others loose or bent out of position. The cavities were packed with decaying food. The lower jawbones were swollen to twice their normal size in the vicinity of the molars. Death was ascribed to old age with teeth condition a primary factor.

On March 9, 1943, a ten-year old ram died on Hannan Sheds. The teeth were similar in condition to that of the above described ewe. Death was probably due to old age with teeth being a major factor. There was no opportunity to perform a post-mortem before coyotes got in their work. The animal stayed in this area for some time prior to his death; for this reason he was observed quite often. Several fecal samples collected earlier showed numerous lungworms (the heaviest infestation found), along with numerous intestinal nematodes, and the only coccidia found in the area.

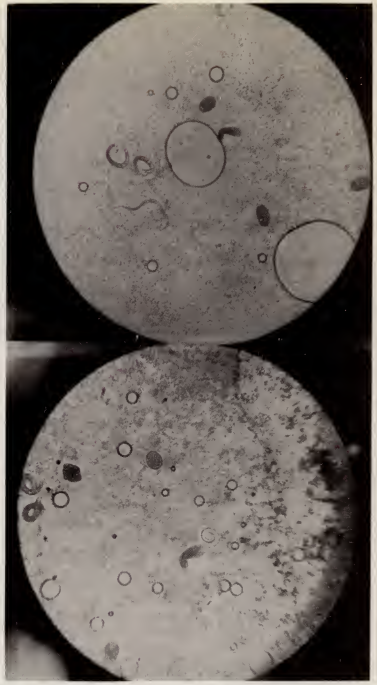
March 15, 1943, the skull and some of the hide of a lamb was found on Spring Mountain. A runt lamb was observed among the eighteen lambs that wintered there and was not seen subsequent to the finding of the skull, although the lambs all scattered about this time. Death was probably caused by coyotes.

May 18, 1943, the leg of a sheep (probably a lamb) was found on Sheep Reef. The sheep had died or been killed during the winter.

In March 1943, a ewe died on the south end of the reef on the east side of Big George. Only the skull was found. A ewe was observed in poor shape and coughing, near here in January.

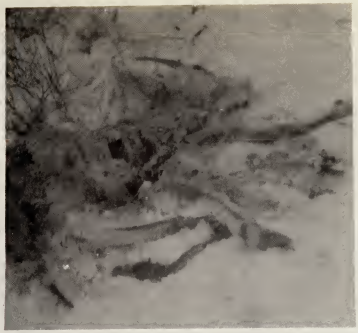
January 12, 1944, a piece of pelt from a sheep was found on Sheep Reef. It had been dead about two weeks but no other remains could be found.

January 27, 1944, a sick yearling ewe was observed in Reclamation Flat. It stood apart from the others, having a stiff, unnatural stance with the head outstretched and making a snuffling noise when breathing. It would shake its head and front quarters frequently. It could not keep up with the others in the band. On January 28th this sheep was seen again near the Allan Ranch with a ewe, a lamb and another yearling. The sick one stood alone and was not observed feeding. It could run at one's approach. On January 29th, this sheep was found alone on top of Spring Mountain, wedged between some rocks in a precipitous place, and almost dead. The observer killed the sheep and brought the head and internal organs to the Allan Ranch. Unfortunately this material froze, making later examination somewhat difficult. When thawed out, the organs presented no pathological appearance. A fringed tapeworm was found in the bile duct. The bronchi showed a red inflamed surface inside and there was a frothy, bloody material in the distal portions of the lungs. No consolidation or abscesses were found, but there was a mucopurulent exudate in the bronchi. This frothy material showed on later microscopical examination, numerous lungworm ova and larvae. No adult lungworms could be found. From the appearance of the lungs and the description of the symptoms exhibited by this animal, it would seem that death was due to pneumonia, possibly as a result from the irritation from numerous lungworm larvae.



Lungworm Ova and Larvae Showing Various Stages of Embryonation and Development.

From the Lung Tissue of a Sheep That Died From Pneumonia.

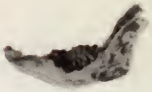


Ewe Dead From Pneumonia
Wagner Basin

On March 25, 1944, a ewe six or seven years old died in Wagner Basin following the first heavy snowfall of this area for the winter. Birds had already torn open the thorax and destroyed most of the liver and small intestine and part of the heart and lungs. The remains of the liver appeared normal although there were several calcified spots found. The lung surfaces were dark red with a grayish, mottled appearance. Light-colored areas on the surface of the lungs were found to contain numerous lungworm larvae and ova (61 X 90 micra). The bronchi were layered inside with a purulent material from which were recovered a number of adult lungworms. There was some consolidation and several adhesions but no large abscesses. Two bots (Oestris ovis) were found in the naso-pharynx. A well-formed foetus was in the uterus and there was considerable fat in the omentum, around the kidneys and heart, indicating that the disease was not chronic or of long standing. No external parasites were found. The teeth were covered with a black shale-like material. They were very crooked and showed abnormal wear; those molars on the left side were worn on the outside surface instead of dorsally like normal teeth, thus leaving a very sharp edge. They were therefore much longer than normal. There was a large abscess on the inside of the right jawbone. Both jawbones were swollen abnormally. This tooth condition has been observed in three dead sheep in this area. Unfortunately none of these specimens could be gotten to a laboratory for a culture. It may be that this tooth infection is necrotic stomatitis.

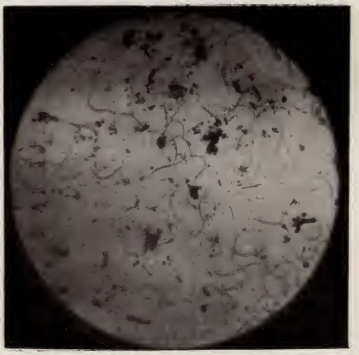
April 3, 1944, a young ram was observed in Scattering Springs, standing in an unnatural position, with head down, and not eating or moving for a long period of time. On April 5th a three-year old ram, presumably the same one, was found near here, having died the previous day. Magpies had eaten some of the flesh from the hindquarters, but the viscera were undisturbed. The animal was quite emaciated. As usual, the thoracic cavity exhibited the most pathological condition. The bronchi were partially filled with a whitish exudate. All lobes of the lungs were dark red with a mottled grayish appearance on the surfaces. Several extensive adhesions were found to the diaphragm, heart and dorsal pleura. One large abscess filled with a creamy purulent material was found. The rest of the lungs were partially filled with a bloodstained mucus. No lungworms were found. Several pieces of the lung tissue as well as some scat samples were saved for microscopical examination. Surprisingly, there were no lungworms found in either. Apparently this was a pure case of pneumonia (Pasteurellosis) with no lungworms involved. The liver did not appear normal. Its ventral surface, as well as the adjoining peritoneum, was covered with many gas bubbles and had a papery sound when touched. This condition may have been due to post-mortem changes. Parts of several tapeworms were recovered from the bile duct. Several cysticerci were

Swollen Jaw of Old Ewe That
Died March, 1943.
Note Missing Molars and Food
Impaction.



Jaw Bone of Ewe That Died of Pneumonia
in Wagner Basin, March, 1944.
Note Crooked Teeth, Black Shale-like
Coating, Swollen Jaw, and Abcess on Inner
Surface of Left Jaw Bone.

Lungworm Larva
High Power Magnification
From Bighorn Droppings



Heavily Infested Bighorn Droppings

found on the mesentery. Numerous stomach and intestinal nematodes were found. The paunch was well filled with food but the colon was empty.

Parasites Found.

The remains of fifteen dead bighorns were found during this investigation and four were in a condition for post-mortem examination. In addition, six trapped individuals were examined externally for parasites. No external parasites were found although diligent search was made for the wood, winter and ear ticks and the scab mite. This was probably coincidental, because winter ticks are reported common on bighorns by other investigators, the sheep have been seen scratching their necks and shaking their heads, and magpies have occasionally been seen sitting on the backs of sheep, presumably getting ticks.

Besides lungworms and their larvae there were found in the stomach and small intestine Ostertagia marshalli, O. occidentalis , Nematodirus sp. Trichiuris sp. ova were found in the feces. A tapeworm from the bile duct was common, possibly the fringed tapeworm, Thysanosoma actinoides. None of the worms of the alimentary tract were numerous enough to be of any pathological significance. No coccidia were found in the Sun River bighorns. Dr. Quortrup mentioned finding a flagellate, Trichomonas sp. in many samples but attached no pathological significance to them.

Scat Analysis.

Between May 1942 and May 1944, 360 bighorn droppings samples were collected over the entire study area. These samples were analyzed for parasites in the field laboratory and a corroborative analysis was made by Dr. E. R. Quortrup, of the Fish and Wildlife Service, Bear River Research Laboratory, Brigham, Utah.

It was early found that the most common parasite was the lungworm (Protostrongylus rushi and possibly P. stilesi; no differentiation has been made between the larvae). Other parasites found were Ostertagia marshalli, O. occidentalis, Nematodirus sp., Trichiuris sp., although definite identification was not made from the ova.

Lungworms have been suspected as being in part responsible for the verminous pneumonia occurring in this and other herds of bighorns. They have therefore been considered quite seriously in this investigation as a possible decimating factor. Lungworms have been reported as the most common parasite of bighorns in most of the states where investigations have been carried on.

The results of examinations showing lungworm infestation have been listed in Tables 11 to 14, according to occurrence in the various units in the Sun River area as well as in the various bighorn areas in the state.

Examination was made by crushing a pellet in a watch glass in warm water. After about twenty to thirty minutes, depending on the temperature, the lungworm larvae became active. This was then examined under a 32 m.m. objective and the sample classified according to whether the lungworms were

abundant, common, scarce, rare, or absent. Numerous tests were made to see if different pellets from the same collection contained the same number of larvae. They checked favorably. In this manner it was thought that one could form a rough index as to the degree of infestation. While there are too many variable factors to make this an accurate index, it does give trends of infestation.

Table 18

Droppings Analysis by Units
May 15, 1942, to June 1, 1944

| | Infestation | | | | | | |
|---|---|---|---|---|---|---|---|
| | Heavy | Common | Scarce | Rare | Neg. | Total | % |
| Sheep Reef | 9 | 8 | 6 | 4 | - | 27 | 100 |
| Reclamation Flat | 25 | 47 | 13 | 6 | 1 | 92 | 99 |
| Scattering Springs | 13 | 18 | 13 | 7 | 3 | 54 | 94 |
| West Fork | 6 | 13 | 7 | 2 | 1 | 29 | 97 |
| Big George | 5 | 7 | 1 | 1 | 3 | 17 | 82 |
| Castle Reef | 15 | 23 | 13 | 23 | 20 | 94 | 79 |
| Willow Creek | 2 | 4 | 4 | 10 | 19 | 39 | 50 |
| So. Fork Deep Creek | - | - | 1 | 2 | 5 | 8 | 48 |
| Total | 75 | 120 | 58 | 55 | 52 | 360 | - |
| Per cent | 21 | 33 | 16 | 15 | 15 | - | - |

Sun River area 85% infestation
Above Big George 97% infestation
Below Big George 79% infestation

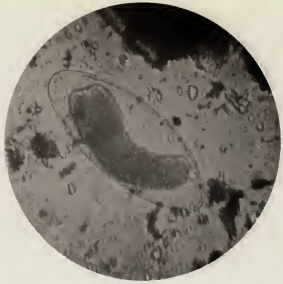
(Willow Creek and South Fork Deep Creek collections were made largely during the summer.)

Table 18 shows the infestation classifications by units. The Medicine Springs area shows a very high infestation amounting to 97%. This is historic range for bighorn, and old residents say they were never found below Big George Gulch in early times. The heavy losses of bighorn in 1924-25 and again in 1927 occurred in this area. Possibly the older, more heavily used range will show a heavier infestation than newer ranges. The lower canyon shows a decidedly less degree of infestation (79%). The Deep Creek and Willow Creek samples were gotten mostly during summer and this is the season when lungworms are least frequently found.

To show a seasonal variation in occurrence of lungworms, Table 19 was prepared, showing monthly occurrence. The per cent infestation shows a decline during July, August, September and October, but increases during the winter months.

When possible, the sex and age of the animals making the droppings were recorded. Not enough of these figures were obtained to have much significance but they have been tabulated in Table 20. It appears that lungworms are

Larval Intestinal Nematode From
Bighorn Droppings
High Power Magnification
West Rosebud River



Ovum and Larva of Intestinal Nematode
Nematodirus or Ostertagia
From Bighorn Droppings
High Power Magnification

about equally distributed throughout both sexes and various age classes. Four of the seven negative examinations were from lambs, possibly indicating that they are more free from lungworms than older sheep. This is to be expected. Lambs examined during the summer months showed no lungworms, the first appearing in December and January, but two samples collected in April showed heavy infestation.

As a result of these examinations, we find that lungworms are general in all groups of bighorns in the Sun River area. They are found to a higher degree where there are heavier concentrations of sheep. Spring Mountain probably receives the heaviest and most continuous use by sheep as it is the center of their winter range, they lamb there, and are occasionally seen all summer in that vicinity. Of ninety-two samples collected from this unit, only one was negative and twenty-five were heavily infested.

During the course of this investigation scat samples were collected or sent from most of the groups of bighorn in Montana and the results of these analyses are listed in Table 21. Lungworm larvae were the most common parasite found and they were abundant in all groups except a small group in the Tobacco Root Mountains which revealed, surprisingly, none. This

Table 19

Seasonal Occurrence of Lungworms
In Sun River Area

| | Infestation | | | | | | |
|---|---|---|---|---|---|---|---|
| | Heavy | Common | Scarce | Rare | Neg. | Total | Per Cent |
| January | 6 | 4 | 8 | 15 | 11 | 44 | 75 |
| February | 12 | 9 | 4 | 2 | 4 | 31 | 87 |
| March | 19 | 39 | 14 | 5 | 1 | 78 | 98 |
| April | 8 | 40 | 19 | 8 | 3 | 78 | 96 |
| May | 2 | 6 | - | - | - | 8 | 100 |
| June | 2 | 5 | 2 | 3 | 1 | 13 | 92 |
| July | 6 | 2 | - | 1 | 12 | 21 | 40 |
| August | 2 | 3 | 2 | 2 | 2 | 11 | 82 |
| September | 1 | 2 | 3 | 4 | 9 | 19 | 58 |
| October | 5 | - | - | - | 5 | 10 | 50 |
| November | 6 | 1 | 2 | 8 | 1 | 18 | 94 |
| December | 6 | 7 | 3 | 6 | 2 | 24 | 92 |

Table 20

Analysis of Droppings from Identified Bighorns

| | Infestation | | | | | |
|---|---|---|---|---|---|---|
| | Heavy | Common | Scarce | Rare | Neg. | Total |
| Rams | 5 | 3 | 5 | 3 | 3 | 19 |
| Ewes | 5 | 7 | 1 | 4 | - | 17 |
| Yearlings | - | 1 | 1 | - | - | 2 |
| Lambs | 2 | 1 | 1 | 2 | 4 | 10 |

Table 21

Montana Bighorn Droppings Analysis

| | Number of Samples | Per Cent Lungworm Infestation |
|---|---|---|
| Ural Tweed (Kootenai) | 5 | 80 |
| Thompson Falls | 10 | 100 |
| West Gallatin | 4 | 100 |
| Mt. Everts, Yellowstone Park | 7 | 100 |
| Stillwater River | 4 | 75 |
| West Rosebud River | 8 | 77 |
| Tobacco Root Mountains | 6 | 0 |
| Sun River | 360 | 85 |

group did have a large number of stomach worms present. Unfortunately no additional samples were obtained from this area to check these findings.

Pneumonia in Bighorns.

The particular species of lungworm involved in this area is Protostrongylus rushi and P. stilesi; both have been found here. The adult worms of P. rushi are found in the bronchi and bronchioles, but P. stilesi migrate back into the smaller passages of the lung and as a result are very difficult to find. The larvae of the two species have never been differentiated. The adult worms which are separate sexed produce many embryonated eggs which usually develop into active larvae in the lungs. These larvae are coughed up and swallowed and passed out in the feces where they may remain for long periods of time. Heavily infested droppings collected in June 1942, were examined twenty months later and were found to contain almost 100% active larvae. They had been dried, stored in a building where temperatures were as low as forty degrees below zero, and through the heat of summer. This shows that they are quite resistant to dessication and temperature changes. The complete life history of this species has not been determined definitely, but one species of Protostrongylus in Europe has been found to pass through a snail intermediate host before it can reinfect sheep. The infective larva passes from the sheep droppings into the ground possibly after rains and, if the snail is near, it bores into the foot of this host. After going through some changes there it emerges and moves up on grass blades when they are wet with dew and may be eaten by sheep, thus completing the cycle. It resists digestive action in the sheep's stomach, bores through the intestinal wall, enters the lymph system, and finally lodges in the lungs. The flat, spiraled land snail is common over the bighorn range in most of the state, so if this cycle is true of the sheep lungworms, they need not want for intermediate hosts.

The pathological picture of the effects of lungworms on the lung tissue may well correspond to that of Dictyocaulus filaria, a lungworm of domestic sheep. T. W. M. Cameron describes it, "When numerous, the worms occlude the bronchi and mechanically interfere with breathing. Their presence irritates the bronchial mucosa, giving rise to an inflamed and catarrhal condition with proliferation of the epithelial cells and the production of fibrous tissue: The inflammation may extend to the adjoining parenchyma, causing a typical peribronchitis. The exudate, consisting of a bloodstained mucus, containing exfoliated epithelial cells, eggs and larvae and many leucocytes (especially eosinophiles and polymorphs) not only assists in the occlusion, but passes backwards to the smaller bronchioles and alveoli. There it causes a localized catarrhal or interstitial pneumonia. In this way considerable areas of lung may be rendered functionless without the aid of bacteria. Atelectosis may occur as a result of the occlusion of the bronchi or bronchioles by the exudate, the worms and their larvae, and a compensatory vesicular emphysema may result. D. filaria causes a verminous bronchitis with a characteristic cough, and frequently a nasal discharge. There is a frothing, often bloodstained mucus in the bronchi and a localized pneumonia--often secondary in its origin--may occur."

While the pathological effects of Protostrongylus may vary considerably from the domestic species, this description applies in general to that

condition found in a number of autopsied sheep in the Sun River area. However, the resultant pneumonia does not seem to be localized, but becomes general, usually affecting all of the lungs, and it, not the lungworms, is probably the direct cause of death.

Pneumonia in bighorn sheep in Montana is not new and has been described as the principal cause of death of bighorns by Dr. Hadleigh Marsh of the Montana Veterinary Research Laboratory. Dr. Marsh (1938) in compiling notes of findings and observations over a period of thirteen years in Montana, describes the losses of bighorns as caused by a respiratory disease of two types. The most prevalent was a chronic pneumonia, occurring mostly in mature sheep and accompanied by lungworm infestation. The other was an acute pneumonia killing two to three-month old lambs on the National Bison Range, and without lungworms being present.

As a result of autopsies performed in the field and from examination of material sent to the laboratory, the same picture has been repeatedly presented. This was that bighorns were primarily infested with lungworms (P. stilesi) with a secondary invasion of Corynebacterium pyogenes, although Pasteurella was always present. Quoting from Dr. Marsh's report: "From fourteen sets of lungs examined, the same pathological condition was found in all cases. There was a subacute or chronic bronchopneumonia. The apical and cardiac lobes of the lungs were consolidated in all cases, and portions of the diaphragmatic lobes were also consolidated. There was usually some pleuritis with adhesions. There were one or more abscesses containing a creamy pus with greenish color. Mucopurulent exudate was present in the bronchi, particularly in the consolidated regions. There was congestion throughout the lungs. The consoliated areas showed a mottled appearance, with small gray nodules a few millimeters in diameter, set in a dark red background. There were usually several firm nodules in the lung tissue in the posterior portions of the diaphragmatic lobes. In one case there was a pericarditis, the pleura was hemorrhagic, and the thoracic cavity contained a large quantity of bloody, seropurulent fluid. In some cases the mediastinal lymph nodes showed some congestion."

No parasites could be found in the lungs, but later the adult of P. stilesi (difficult to find as it stays in the smaller bronchioles) were identified. Numerous ova and larvae of this lungworm were found in the smaller bronchioles as well as in the bronchial exudate.

Dr. Marsh also describes a Pasteurellosis or acute pneumonia occurring in lambs at the National Bison Range. No lungworms were present in these cases.

In a report by Dr. Richard Bond, June 7, 1937, "Continuation Report on Bighorn and Bighorn Sickness in Glacier Park", it was found that, of 54 bighorns in the Many Glaciers area in 1936, only 17 survived that fall and winter. There was a severe fire in September 1936 in which three sheep were lost, but thirty-three were known to have died from disease. The destruction of part of their range by fire, the destruction of much of their winter range by concessionaire horses, and the practice of concentrating the bighorns by artificial feeding--all probably contributed to or lead up to the severe

diseased condition of these bighorns. Through cooperation with Dr. Marsh it was found that the disease was similar to that found by Dr. Marsh in the severe epidemic of 1926-27 in this area and also found in the Sun River and in Yellowstone Park. These findings were "that the primary condition of these sheep was pneumonia caused by infestation with a lungworm (P. stilesi), with a secondary bacterial infection which was the immediate cause of death. The Pasteurella (incriminated by Dr. Bond as the cause of the disease) was present in the lungs, but another organizm, Corynebacterium pyogenes, was the principal invader. Of the twenty-six bighorns that died in 1926-27 (December and January), 14 were ewes, 7 rams and 5 yearlings. Those dying in 1936-37 (December, March and April) were mostly adults, sex about even.

Since this time the concessionaire horses have been removed and the practice of feeding bighorns has been discontinued. The latest report on the Many Glaciers band is 48, and they appear in good condition (1943).

## PREDATOR RELATIONSHIPS

During the course of this investigation no direct evidence of predation on bighorn sheep has been observed. There is an argument that a certain amount of predation is necessary in the balance of nature to make an animal more alert and, through the survival of the fittest, be better enabled to take care of itself. It is felt in this case that every limiting factor as a source of loss of bighorn should be considered in an effort to get the herd back on a stable footing. The existence in this area of several potential predators merits a discussion of each.

### The Coyote.

Coyotes appear to be the most serious predator on bighorns in this area, but they probably have little effect on the herd in general. Bighorns normally seem to be able to cope with coyotes by banding up and keeping close to rock cliffs. Probably coyotes pick off an occasional stray that gets cornered in deep snow or is weakened by starvation or disease. During severe winters this number may be materially increased.

There seems to be good proof that coyotes will kill sheep. During March 1943 a runt lamb was observed in a group of eighteen lambs that wintered by themselves on Spring Mountain. This particular lamb did not seem weak or sick, but one morning it was missing and tracks showed where it had been torn to pieces by coyotes. Mr. Ben Graham, a rancher near Ural on the Kootenai River, told last summer of actually seeing a coyote kill a three-month lamb. The ewes that were with it ran off, showing no tendency to try to protect the lamb. He also saw a ram get killed in deep snow by two coyotes. Another ram was observed to have been killed by coyotes near Mammoth in Yellowstone Park.

When this investigation began, coyote droppings were collected when encountered. Because of lack of personnel at food habits laboratories, no positive identification of foods was possible and collections were discontinued. The presence of sheep in their food does not mean that the coyote killed the sheep and, unless droppings collections are made on an intensive scale

and over the entire area, they are of little value.

Bighorns seem to have some fear of coyotes. Bands have been observed to become alert when coyotes are in the vicinity. When crossing flats, sheep have been observed to run at full speed until they have reached rocky, precipitous places.

Coyotes are very numerous in the Sun River country and are reported very numerous in the Ural-Tweed and Thompson Falls areas. One reason for this is the lack of trappers since the war started. Also, the Sun River coyotes are quite mangy, making them valueless and discouraging trapping.

During 1948 and 1949 a very heavy campaign has been waged on the coyote through the use of 1080 poison. The effects of the resultant predator reduction has been a boon to the sheepmen and seems to have caused an increase in all game populations involved. However, bighorn herds live in the more inaccessible areas where this coyote-control program has not been operating. They have not been given a great deal of protection from the coyote to date.

The Wolf.

Wolves have likewise, until recently, been a rarity in this area. The last one killed was on the North Fork four years ago. In June 1942, one was seen at the head of Blacktail Gulch. In December 1943, one was seen crossing Pretty Prairie. Various reports, unverified, come in about wolves or tracks from the foothill region outside the mountains. While they are not a threat now, they probably will be if not controlled, and constitute a considerable menace to big game populations.

The Mountain Lion.

Lions used to be common in this country but heavy trapping with large bounties made them almost extinct. Recently they have begun to show up again. During the fall of 1942 a hunter saw tracks in Green Timber Basin on Beaver Creek, an old haunt where lions were common. In February and again in March 1943, tracks of a lion were seen crossing Pretty Prairie. The remains of two white-tail deer were found where this lion had visited. In May 1943, a track was seen at the head of Beaver Creek by Forest employees. In February 1944, a lion was observed at the head of Arsenic Creek lying in wait on a ledge above a small group of elk. It became frightened and ran north, continuing into Cabin Creek where its tracks became obliterated by drifting snow.

One could expect serious losses if lions became very numerous, as they are considered hereditary enemies of sheep and require fresh meat quite often.

Bear.

Black bear are common over the entire area. They are not considered seriously as predators on sheep. Sheep have been observed grazing on a hillside while a bear was busily turning over stones within fifty yards and

causing them no concern. They are usually in their dens when the most damage could be done to sheep--that is, in late winter when range conditions might be poor.

Grizzlies are common in the Sun River drainage but are not considered predators on sheep. During this investigation, most scats of both black and grizzly bear have been examined when encountered. While most of the material was vegetable matter, insects and rodents, there was some evidence of big game hair, but only in the early spring when they feed on the remains of winterkilled animals, or during late fall when they cleaned up the leavings of the hunter kills.

3 Ewes and Lamb
Wagner Basin Trap

2 Year Old Ram
and Lamb
Wagner Basin Trap

Golden Eagle Two Months Old
in Nest

Eagles.

No bald eagles have been seen in this area.

Golden eagles are common in Sun River, and their relationship to big game, especially bighorn sheep and goats, has been a matter of much speculation. Reports are common of attacks by these eagles upon lambs or kids. The usual procedure is for the eagle to dive at the young animal, forcing it to jump or fall from a cliff and get killed, where the bird can feed at leisure. For a person to see this more than once in a lifetime would be exceptional.

During the summer of 1943, an eagle's nest was kept under observation while the young were present. The nest could be approached to within thirty feet so that the foods present could be identified quite easily. Below is a list of the dates of visits and the foods identified.

July 1942. Nest was first seen but was uninhabited. There was a bone in the nest which was recovered and sent to the Patuxent Laboratory, Bowie, Maryland, for identification. This bone was found to be the humerus of a domestic sheep. There have been no sheep within twelve miles airline from this nest for many years.

May 19, 1943. A young eagle and an unhatched egg were in the nest. The remains of eight columbian ground squirrels lay about the nest.

May 27, 1943. Only one young; the other egg did not hatch. Twelve columbian ground squirrels there.

June 7, 1943. Five ground squirrels and

Golden Eagle Nest
Big George - Bone in
Nest was Identified
as Domestic Sheep

one blue grouse.

July 1, 1943. Three ground squirrels and one wood rat.

July 7, 1943. One pine squirrel. I spent all day hidden near the nest hoping to get a complete daily check but nothing was brought in.

July 28, 1943. No food. Bird quite large and walked around nest flapping its wings.

July 29, 1943. A fawn's foot with ten inches of leg bone attached.

August 11, 1943. Young eagle gone. The fawn's foot was still there along with what appeared to be the scapula of a fawn.

From these observations it appears that the main food of young eagles is rodents and other small animals or birds. With the progress of the season possibly the ground squirrels get more wary and certainly harder to see, or it is possible that the young eagle devours the squirrel in its entirety, explaining the progressive scarcity of rodents in the nest. Larger animals appear in the diet later in the summer, perhaps because of the increased demand for food for the growing eaglets. It is unknown how much of their diet consists of larger animals and cannot be determined except by direct observation, because many pieces of meat might be brought in without identifying bones being present. No definite evidence has been found that bighorn sheep have been used for food, although there seems nothing to preclude this fact, as deer were found to have been taken. In February 1943, two eagles were seen feeding on a calf elk that died in a storm the night before; they had eaten the liver and the heart.

Poaching.

The degree of poaching is difficult to establish and as a result we have a questionable amount of loss in all game areas.

In the Sun River area it is felt that there is very little loss from this source. The sheep are very tame, showing little fear of man. Evidence was found of only one case of illegally killed sheep. This was in Arsenic Creek during hunting season, where the hindquarter of a sheep was found hanging from a tree and had been almost entirely used. One could hardly expect no bighorn loss during a hunting season when hunters are combing the mountains for deer and elk in the very area where the sheep are concentrated during the breeding season. The fact that only one carcass was found and that there were no reports of kills, leads one to believe, however, that few sheep are lost in this manner. Sheep in other areas vary in their attitude, some being exceptionally wild. Those seen at Thompson Falls and in the Tobacco Root Mountains showed this characteristic and, according to best reports, poachers take quite a toll from these groups.

RECREATIONAL USE OF AREA.

The Sun River country is noted for its excellent fishing, hunting and

scenery which makes it very popular for holiday seekers, tourists, hunters and other recreationists. There are about fifty summer homes and several dude ranches here who make heavy use of the many trails in and adjacent to the Sun River Primitive Area. The fact that upper Sun River has no roads makes it unique in this respect. Hunter use is heavy, as this is one of the largest elk herds in the state. One of the biggest thrills most of these people get is to see a group of bighorns or especially a bighorn ram. Bighorns unquestionably play a large role in adding to the aesthetic value of this area.

TRAPPING AND TRANSPLANTING OF BIGHORNS.

During the past three years several traps have been constructed for capturing bighorns. One was made on the Kootenai in the Ural-Tweed area, one on the West Fork of the Gallatin River, two on Sun River, and one on Deep Creek in Teton County. This latter was primarily for catching goats but bighorns frequent it. The main purpose of these traps was to transplant to other areas and to get a few rams interchanged in these areas. One ram was moved from the Gallatin to the Sun River. Two rams were moved from the Ural-Tweed area to the Gallatin. Fourteen ewes, young rams and lambs were taken from the Sun River and planted in the Gates of the Mountains area northeast of Helena. There were many bighorns there at one time but they have since disappeared.

These traps vary in size somewhat because they were experimental, but they were constructed of poles set in the ground and covered on the inside by woven wire to a height of eight feet, making an enclosure of about twelve feet by twenty-four feet. A trap door is at each end of the trap and left open until the sheep get used to coming in to the bait of salt placed in the middle, and they will come to it readily. They have been observed coming to the trap during every month of the year, but during the months of green grass in the spring and fall they are more common. After the sheep have come in a few times, one of the trap doors is closed and the other one set with a wire trip which an observer can pull.

It was found that woven wire caused some injury to the noses and heads of the sheep because they could see the surrounding hills and would run headlong into the walls of the trap. A wall of boards, canvas or burlap will prevent this as they cannot then see out.

The sheep are caught with a rope or by hand and placed in crates for shipment. Special crates were constructed for packing on a horse which worked satisfactorily. After the arrival of a truck they were placed in shipping crates or compartments.

Several of these bighorns were kept for several weeks in a holding pen. They were fed hay and small amounts of rolled oats and were found to have gained in weight.

In 1947, eight bighorns were trapped in the Sun River area. Two large rams from this group were released in the Gallatin. Two more large rams and the remaining four ewes and yearlings were released on Wildhorse Island in

Flathead Lake. This was to augment a small band that already existed on the Island from a previous plant. There were about twenty-three (?) head of bighorns on the Island during the summer of 1949.

It became apparent early in this study that the best way to help the bighorns would be by rehabilitation on new range. This should be historical range that would probably be free of parasites and disease, and would present a disrupted predator balance, both of which should be a great asset towards getting a new group established.

The badlands of eastern Montana present such a historical range and land uses at present are such that this much needed protection is afforded. This type of terrain constituted the home of the now extinct Audubon subspecies of mountain sheep, the last one of which was killed in 1916 in the Missouri Breaks area. (See section in appendix on Audubon bighorns by W. K. Thompson.)

Because previous experience with releases in large areas resulted in extreme dispersion and failure of plants, it was decided to construct a holding pasture in the Missouri Breaks area in which trapped animals could be held until they could become localized or used to the habitat. A fenced enclosure was constructed in 1947 on Billy Creek. It is located partly on leased private land and partly on land under control of the Bureau of Land Management. The area adjoining is on the Fort Peck Game Range under the administration of the Fish and Wildlife Service. The utmost cooperation has been shown by these agencies and the owners of the leased land.

The enclosure is 320 acres of predominantly prairie grassland including the heads of several timbered draws which contain adequate water and browse and lower down provide very steep, precipitous badland formation for escape cover.

In the fall of 1947, sixteen bighorns were obtained from the famous thrifty Tarryall herd in Colorado. This was a well-balanced group consisting of two adult rams, three young rams and the rest ewes and lambs. They survived the winter well and produced six lambs (three male and three female) the following spring. The summer of 1948 produced exceptionally fine forage and survival was 100%, although one of the rams, in fighting, was knocked outside the fence. He remained on the outside of the fence, bedding as close as possible to the rams on the inside. In the spring of 1949, ten lambs were born, making thirty-two head or just double the original plant. It is felt that these bighorns are now well located and present plans are to release about half of this group this fall outside the enclosure. The balance will be retained to serve as a nucleus for another similar plant in the Glendive Badlands.

DISCUSSIONS AND CONCLUSIONS:

Most of the bighorn herds in the state are not increasing. Some remain in a static condition. Others may build up to fair numbers and then suddenly die off from disease. This fluctuation has been reported as occurring for the last fifty years, probably since white men came in and reduced their numbers by hunting; then they were crowded into small areas where they had

to compete with other game, man and his livestock. Their low resistance to disease, coupled with a drain from predators and poachers, has been enough to keep their numbers in check.

1. Age Classes and Sex Ratio.

An analysis of Tables 4 to 8 inclusive, will give a fair indication of the present condition of the Sun River bighorns. The number of lambs surviving their first year is good. A ewe-lamb ratio of 1 to .54 is indicative of an increasing herd, and this compares favorably with the healthy Tarryall herd of Colorado. However, there is a decided decline in the per cent of yearlings during the summer months, as shown in Table 5, and it is in this respect that the Sun River herd differs from the Tarryall herd. One factor should be considered in regard to this apparent decline, and that is the increasing difficulty of distinguishing yearlings after their second summer.

As two and three-year old rams are quite easily identified, one would be safe in assuming that twice their percentage figure would represent the number of sheep surviving their second and third years. This amounts to 11% and 8% respectively. Table 4 shows about 12% yearlings and 24% lambs, indicating clearly a loss of yearlings, and according to Table 5, this loss occurs during the summer months. No carcasses were found during the summer but they could easily have been missed due to the more extensive and more precipitous range occupied by bighorns at that time.

The reversal of sex ratio described by Gammill and Rush in Yellowstone Park does not appear here. Sexes are about equal and the tables show one mature ram to two and one-half ewes. The ganging up on ewes by five to nine rams has been observed occasionally, but this is not considered detrimental and no ewes were seen suffering as a result of these melees. This seems to be nature's way of eliminating weaker animals and also assuring pregnancy.

Some concern has been expressed regarding the abnormally long breeding season for bighorns. In this investigation no lambs were found born prior to May 10th nor later than June 15th and the big majority of them were born between May 20th and June 5th. This compares favorably with the other big game animals. Mating activities have been observed as late as January 4th and reported even in February, but this may not have been actual breeding, as young rams have been observed trying to mount ewes during almost every month of the year.

2. Effects of Weather.

As far as could be determined during the two years of study, severe weather conditions have little direct effect on bighorns. Severe cold and deep snow forced elk to compete with bighorns but the latter did not seem to suffer abnormally, while quite a few of the elk died in this particular area. Concentrations of bighorns were observed before storms and a scattering after storms.

Because more sheep were lost through disease during the past mild winter than during the previous severe winter, the thought has occurred that possibly mild winters are more apt to favor the development of parasites and

disease. The severe loss of 1924-25 occurred during a mild winter.

3. Range Competition.

According to the tables on range use by units, it would appear that elk and deer compete quite seriously with bighorns. This is at present not a serious condition because the few bighorns present are able to occupy the more precipitous, sparsely vegetated areas with little cover and these are not frequented much by elk and deer. Horses from dude ranches and hunting camps on the Sun River cause heavy use on critical winter elk forage. This, in turn, with a heavy concentration of elk, could cause extreme competition with the bighorns. When elk are found on bighorn range for very long periods of time, the sheep have been observed to leave. With the recent acquisition of adequate winter elk range in the area outside the mountains, the possibility of this competition is lessened. The elk are now forming the habit of migrating early through to this wintering ground and it is expected that the bighorns will be thereby benefited.

4. Carrying Capacity.

Based upon the type of range now occupied by bighorns, and assuming that numbers of elk and deer are held at about their present numbers, one could safely allow the Sun River mountain sheep to increase to 750 to 1,000 head. A better distribution of bighorns would, however, be desirable to avoid too heavy concentration in the Medicine Springs area. This could quite probably be accomplished by devising a salting plan to hold them back on higher range.

5. Parasites and Disease.

Pneumonia is the principal cause of loss of mountain sheep as determined by post-mortem examinations. Lungworms may be the basic cause of this disease and these parasites are abundant in almost every herd in the state. Adult sheep of both sexes were most commonly found dying from pneumonia although all other ages of sheep older than nine months were found, from fecal analysis, to have carried lungworms. This gradual loss, coupled with an occasional loss from predators and poachers, could easily be enough to keep our Montana bighorns at a static or even decreasing population. With proper conditions this incipient disease could have, and apparently has at times, resulted in epidemic proportions.

An infection of the lower jawbones resembling necrotic stomatitis has been found in a number of sheep that died in the Sun River area. This may be a possible cause of death in bighorns.

It is quite well agreed among investigators but not too well among laymen that diseases of domestic sheep are not necessarily communicable to bighorn sheep. Certain parasites of bighorns are not found on domestic sheep and the reverse is likewise true. Those that now appear common to both, may, upon later more detailed examination, prove to be a different species. For this reason, one should hesitate to blame domestic sheep for infesting bighorns with certain diseases or parasites.

Treatment of disease in wild animals is at present believed impractical but, with diseased animals, one of the first remedial measures is isolation. Possibly a few of these sheep placed in a new environment would be able to throw off this diseased condition and start a thrifty herd. If lungworms require a snail intermediate host, possibly moving away from infested areas will prevent this parasite from completing its cycle.

6. Predators.

Every source of loss should be considered when our bighorn herds are at such a low ebb. Coyotes, the main predator, and mountain lions and wolves should be carefully controlled in all bighorn areas until the herds show a definite increase.

7. Poaching.

Illegal killing goes on in most areas, more in some than in others. Laws should be strictly enforced but probably the best method of attacking this problem is by public education. Public sentiment appeals should be made to the hunters, ranchers, dude ranchers and sportsmen regarding the aesthetic value of bighorns, presenting to them the history of extinct herds, and the danger of extinction of remaining herds. Moving pictures and lectures at sportsmen's meetings, fairs and in schools should stress the need of protecting this rare big game animal.

8. Inbreeding.

The thought is rather prevalent that our bighorn herds have been isolated in small groups so long that they have become inbred, run-down, decreased in size, become impotent, barren, and less disease-resistant. Little evidence to support this has been found in this investigation other than that bighorns are subject to parasites and disease, and this is true of all Rocky Mountain bighorn. Rams have been seen wandering great distances from known bands of sheep. This wandering habit should insure a mixture of breeding stock in most bands.

Several traps have been constructed for the purpose of catching sheep and the thought was to interchange a few rams from several of our bands. Lack of manpower has curtailed operations for the present.

9. Transplanting.

Possibly one of the best ways to insure a continuation of our bighorn herds is to transplant some of them to a different range and hope to get a new group started. This range should be historical range of bighorn and care should be exercised in choosing it so that adequate protection can be given regarding competition from livestock and other big game, predators and poaching.

One area has already been investigated and is considered suitable for such a plant. This is in the Missouri River Breaks in northern Garfield County, partly in and adjoining the Fort Peck Game Range. This "badlands"

type of country is very rugged, presents suitable and sufficient forage and water, and, according to our best records, is the site where the last Audubon sheep was killed in 1916. Predatory animal control has been carried on there by government trappers and the Fish and Wildlife Service is willing to cooperate in furnishing patrolmen for the area.

Another suitable area is in the badlands south of Glendive where bighorns were once abundant.

The land use and status has changed in the last few years, pointing toward a more healthy condition for big game in these areas.

RECOMMENDATIONS.

1. Considerable thought has been directed toward the development of a mountain sheep ranch on which many of the questions pertaining to bighorn might be solved. An excellent location for this "ranch" would be in the Sun River area on the south end of Castle Reef. This is natural bighorn range and is typical of their habitat. A fence should be constructed around about two square miles of this area and about fifty bighorn sheep kept there for study purposes. Cross fences, plots and pens would be necessary in which numerous studies could be carried on. These would include nutrition--palatability of various natural foods, amounts required, effects of overgrazing, artificial foods, et cetera; mineral requirements; breeding experiments--effects of inbreeding, optimum sex ratios, crosses with other species or subspecies; disease and parasites--experiments with drugs, medicines, serums and vaccines to prevent or cure diseases common to bighorns, methods of eliminating parasites, and possibly determining life history of lungworms.

As an aid in the solving of specialized research problems, advantage should be taken of facilities that are available at various state and federal institutions. Such institutions are the Montana Veterinary Research Laboratory at Bozeman, Montana; Montana State College, Montana State University, Montana Livestock Sanitary Board, U. S. Public Health Laboratory at Hamilton, Food Habits Division Research Laboratory of the Fish and Wildlife Service, and others.

An important phase of this "ranch" would be to use the increase from the herd or stock for re-establishing this big game animal in other selected areas.

Kenneth Thompson, who was on leave from this department during the war and stationed with the U. S. Navy at San Diego, had occasion to visit the City Zoo there. He learned that the European Moufflon sheep has been found to be free of parasitism from lungworms. It has also been found that this wild sheep from the mountains of Corsica and Sardinia will successfully cross with our Rocky Mountain bighorn and that the resultant offspring is apparently immune to lungworms.

How far this immunity may extend through the blood lines of this cross is not known. The possibility of immunizing our mountain sheep to lungworms

by introducing the blood of Moufflon sheep presents a possibility that should be investigated upon an experimental basis at least. This could be ideally carried out as one of the projects of the proposed mountain sheep ranch.

2. Phenothiazine (P.T.Z.) successfully combats certain intestinal nematodes of domestic sheep. This is administered by offering salt containing 10% P.T.Z. in powdered form. As bighorns harbor similar parasites which may have more or less deleterious effects, it is thought that some of this treated salt should be provided for Montana bighorns. In line with good salting practices, this salt should be placed on the upper extremities of their winter range.

To be of benefit this drug must be supplied fairly fresh. If exposed to direct sunlight it oxidizes and loses its beneficial value. If a salt mixture were supplied every two weeks, in a covered trough, during the spring and fall months, some good effects might be realized. The drug does not remove worms but it prevents embryonating of the eggs after they pass out onto the soil and thus inhibits the spread of these parasites.

3. It would be desirable to take about ten rams annually from the Sun River area by hunting. A regular open season would not be advisable as there is danger of taking too many. If these rams could be taken by a special license system under the supervision of Department representatives or guides, some benefit would be realized from the herd, no harm would be done, and the resultant activity might make the remaining sheep more alert and conscious of danger from humans.

4. Trapping operations should be started as soon as possible and a mixed group of fifteen bighorns containing at least two mature rams should be released in the Billy Creek-Snow Creek area in the Missouri Breaks north of Jordan (this primary plant may be obtained from Colorado).

Another group of ten bighorns, including two mature rams, should be released in the badlands southeast of Glendive.

Present investigations in central Montana may reveal other suitable areas for planting bighorn.

5. A definite program of predator control should be carried on in all bighorn areas in the state. This should be done by state trappers. The coyotes are quite mangy in the Sun River, making their pelts valueless and discouraging trapping at present.

Wolves and mountain lions should be rigidly controlled on the mountain sheep range of the Sun River area.

6. A large, roofed sign should be made and placed at the entrance of the Sun River Canyon during hunting season. This sign should show in color a ram, ewe and lamb. This should help prevent confusion of bighorn with other game. While no evidence of bighorns killed accidentally was found, there have been reports of this, and a ewe can easily be mistaken for a buck by novices. Then, too, the hunter will be more conscious of bighorn in the area.

APPENDIX

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BIGHORN MEASUREMENTS

| Place | Circum. at Base | Outside Length | Between Tips | No. of Rings |
|---|---|---|---|---|
| Gibson Dam. | 15" | 38" | 17" | - |
| Allan Camp. | 15.5" | 36.5" | 18.5" | 12 |
| Allan Camp. | 15" | 36" | 21" | 5 |
| Allan Ranch | 15.5" | 36" | 21" | 5 |
| Allan Ranch | 14" | 29.5" | 16" | 5 |
| Allan Ranch | 14.8" | 34" | 22" | - |
| Bruce Neal Ranch. | 14" | 29" | 19" | 4 |
| Wagner Basin (died) | 15" | 38" | 24" | 6 |
| Ed Druckmiller cabin. | 13.8" | 34" | sheaths | 10 |
| Big George (died, broken) | 14" | 37" | - | 13 |
| Mrs. DuShon cabin | 15.3" | 41" | 22" | 12 |
| Castle Reef, Hoxey field, died. | 16" | 33.5" | 17" | 6 |
| Office, Helena, Fish & Game | 15.8" | 38" | 19" | 12 |
| Gallatin ram, transplanted. | 14" | 30" | 18" | 10 |
| Mammoth, YNP. | 14" | 36" | 20" | 9 |
| Mammoth, YNP. | 15" | 38" | 24" | 8 |
| Mammoth, YNP. | 14.5" | 38" | sheaths | 9 |
| Mammoth, YNP. | 15" | 36" | 18" | 8 |
| Mammoth, YNP. | 13.8" | 35" | 18.5" | 10 |
| Mammoth, YNP. | 15.5" | 38" | 19.5" | 11 |
| Audubon sheep, Miles City | 14.5" | 30.6" | 20" | 10 |
| Average | 14.7" | 35.6" | 20" | 8.6 |

# HISTORICAL RANGE AND NOTES ON AUDUBON MOUNTAIN SHEEP

by

Kenneth Thompson

## INTRODUCTION.

In attempting to define the range of a subspecies, it is necessary to make critical examination of good specimen material. This is particularly true in determining the line of separation between one subspecies and another where the two meet. However, in the case of Audubon sheep, practically the only material available is in the form of mounted heads. At this time, there are no data which make it possible to differentiate between a taxidermic specimen of Ovis c canadensis and Ovis c Auduboni although many of each subspecies are available.

For these reasons, the purposes of this report are met by assuming that the line of demarcation is a physiographic one. While it seems probable that the characteristics of these subspecies merged imperceptibly where they met, the delineating line is tentatively made on the basis of land topography. All mountain sheep found in the badlands, Map 1, are assigned to the badland subspecies while those west of this line and in the mountains will be considered canadensis.

## ORIGIN OF MOUNTAIN SHEEP.

Before going into the distribution of the badland sheep, it is desirable to review the probable origin of mountain sheep in this continent, particularly as this is important in some of the implications made later.

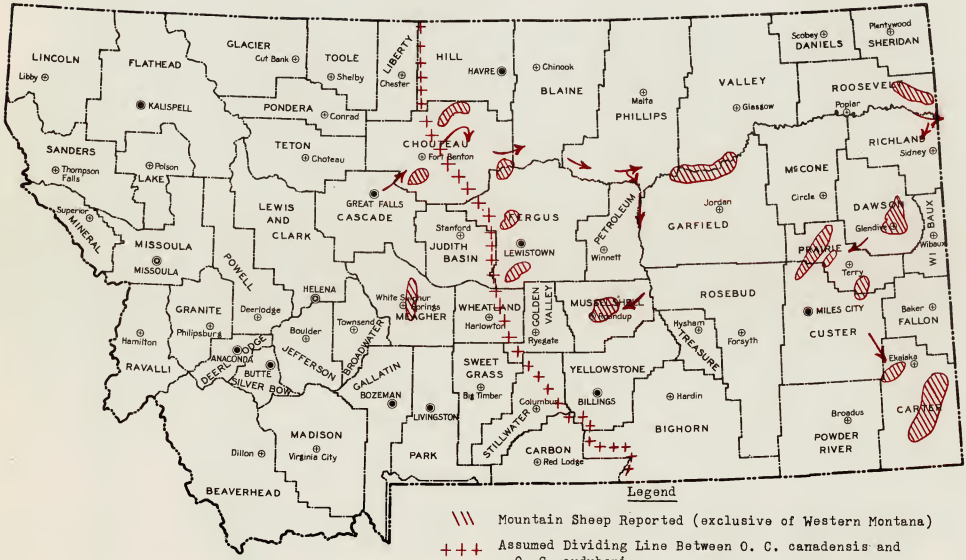
Probably one of the simplest and most widely accepted theories is that advanced by Hornaday. The following is a quotation from Vol. 1, American Natural History by W. T. Hornaday: "It seems highly probable that a number of species of North American mannals and birds were acquired by emmigration from the Old World. Of this there is no stronger evidence than that furnished by the genus Ovis, which was cradled in the mountains of Central Asia. Western Mongolia and Thibet have produced the colossal Argali, the wonderful wide-horned Polo sheep and the robust Scar sheep. As the genus spread southward, it produced the small Urial and Burrhal, and stopped short at the northern edge of the super-heated plains of India. But northward its fate was different. From the place of its nativity--let's say the Altai Mountains--there stretches northeastward through Siberia and Kamchatka, Alaska and British Columbia to northern Mexico a practically unbroken range of mountains 7,500 miles long. From northern India to northern Mexico, the species stand in the following order: Burrhal and Urial, Argali and Polo's sheep, Scar sheep, Kamchatkan sheep, white sheep, black sheep, Big Horn, Nelson's and Mexican sheep."

This theory of immigration from Asia to North America by way of the Bering Strait is accepted in various forms by most authorities. It is mentioned here because it presupposes a movement of the genus Ovis from north

# MONTANA.

Map 1.

Badland Sheep Range




Legend

\\\ Mountain Sheep Reported (exclusive of Western Montana)

+++ Assumed Dividing Line Between O. C. canadensis and O. C. auduboni

→ Possible Direction of Migration

to the south, which suggests that Auduboni developed as an offshoot from typical canadensis and therefore originated in the north and western mountains of the state. From this start it probably expanded east and south through the badlands of eastern Montana.

From the evidence available it seems probable that the breaks of the Missouri River were the first to be occupied by the badland sheep. From here they could have expanded south down the Musselshell to the Bull Mountains, eastward along the badlands of the Missouri to its junction with the Yellowstone River and then continued into the Dakotas by way of the Missouri.

Along the Yellowstone the route seemed to reverse and go westward, leaving well-established bands in the Glendive breaks, the Sheep Mountains around Terry and thence westward to about Forsyth. No data is available of mountain sheep being found west of Forsyth.

Another branch of the Yellowstone movement appears to have gone down the Powder River breaks and sending offshoots as far as the Chalk Buttes and Finger Buttes of Carter County.

Obviously the migration suggested above is purely theoretical and based upon two facts: First, the reports which have indicated much of the habitat occupied by sheep and, secondly, the fact that sheep were always found in or adjacent to steep rugged country. At present no reports have been obtained of sheep in the open flat prairie.

If the above deductions are correct, and the variations found between O. c canadensis and O. c auduboni are inherent characteristics derived from a survival value in this environment then it should be possible to demonstrate a greater difference between Auduboni in the Missouri Breaks and Auduboni and the Chalk Buttes or Powder River from the type specimen of O. c. canadensis.

DESCRIPTION OF THE BADLAND SHEEP:

Superficially mounted specimen of Audubon sheep and the mountain bighorn appear almost identical and it seems likely that what differences occur were developed through centuries of environmental differences.

Probably sub-speciation of the mountain sheep is based upon insignificant characteristics when the chief difference may be largely a matter of adaptation to the different environments.

Cowan, in his report on *"Distribution and Variation in the Native Sheep of North America" demonstrates a significant difference between these two species in the nasal and maxillary width of the skull of females. "In each auduboni is larger than canadensis."

"The males on the other hand are significantly different only in width of the basioccipital in which canadensis exceeds auduboni and possibly also

* The American Midland Naturalist No. 3, Vol. 24, Nov. 1940.

in length of upper tooth row."

He found no difference in the spreading type of horn.

As to pelage auduboni was found lighter than canadensis from mounted specimen and this is reported by Cowan* and Anthony**.

If the early taxidermists can be relied upon, the color of the eye of the badland sheep was considerably darker than that of the mountain bighorn. Size and body characteristics appear similar although the badland sheep may have been rangier than canadensis.

HABITAT OF BADLAND SHEEP.

Badland sheep have been reported only in the rough, broken river breaks which are found along the major waterways of eastern Montana. Protective timber or brush did not seem to be a prerequisite of the sheep's range as much of the land used by the species is denuded (and apparently has been for years) of any sizable tree or shrub.

Early explorers noted this tendency of the badland sheep to use the badland country. Audubon wrote that the badlands were the chosen pastures of the mountain sheep and added, "The only idea I can give you in writing on what are called "Mauvais Terres" would be to place some thousands of sugar loaves of different sizes from quite small and low to large and high, all irregularly truncated at top and placed somewhat apart from each other. No one who has not seen these places can form any idea of the resorts of the Rocky Mountain Rams or the difficulty of approaching them, putting aside their extreme wildness and marvelous activity.

They form paths around these broken-headed cones (that are from three to fifteen hundred feet high) and run around them at full speed on a track that, to the eye of the hunter, does not appear to be more than a few inches wide but which is in fact from a foot to eighteen inches in width.

No one can image how they reach these places and that, too, with their young, even when the latter are quite small. Hunters say that the young are usually born in such places, the mothers going there to save the helpless little ones from the wolves which after men seem to be their greatest destroyers."

Father DeSmet wrote in 1846 "The habits of the mountain sheep are not like those of any other creature. He chooses for his favorite dwelling the ruggedest spots of the inaccessible mountains."

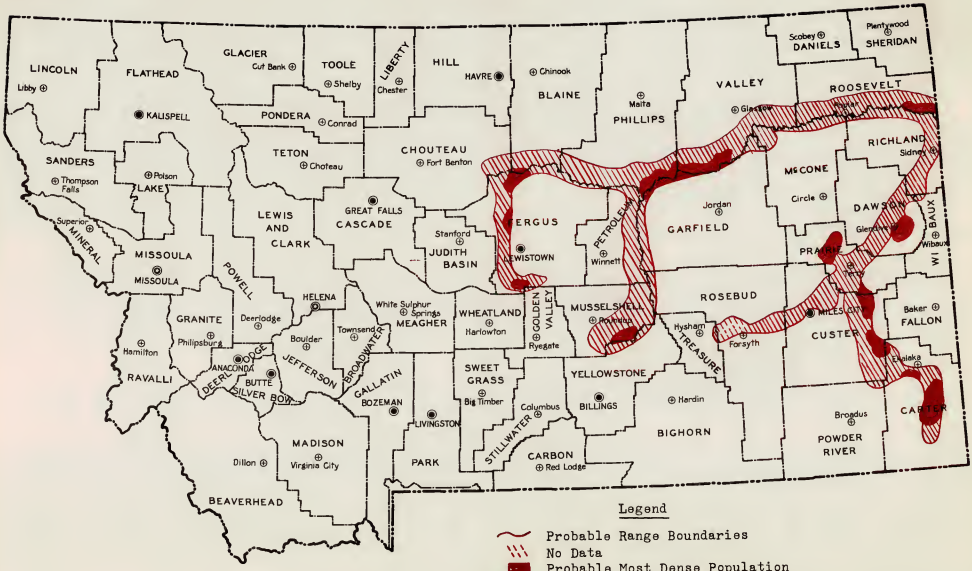
These observations are in agreement with those of the men contacted who had been familiar with these animals. One resident who had attempted to rope one upon several occasions, said, "They were always too close to a jumping-off place."

* The American Midland Naturalist No. 3, Vol. 24, Nov. 1940.
** Field Book of North American Mammals.

Historic Range of Audubon Sheep
in

Map 2.

# MONTANA.



Use has been made of these statements in determining the probable range of the badland sheep by connecting all rough broken country between points where the sheep were reported and assuming that they moved through this rough terrain rather than to cut across open prairie.

DESCRIPTION OF BADLAND SHEEP HABITAT.

Pictures of typical badland sheep habitat are shown on accompanying pages. In general, the type of country in which they have been reported is composed of rough and deeply eroded badlands. Vegetation is found to be typical of the plains badlands and consists of grasses, sage, shadscale, snakeweed, with juniper and brush in certain exposures.

Missouri Breaks and the Glendive badlands appear to be the most ideal habitat in eastern Montana. They are extremely rough and inaccessible but at the same time provide water and good forage.

The breaks of the Powder River are rough and broken with forest covering in certain portions but the Sheep Mountains of Prairie County are a rather high ridge which have practically no brush but abound in grass. The terrain is much less eroded than in the other areas described.

In Musselshell County, the Bull Mountains present a favorable sheep habitat in certain portions, being composed of several steep, flat-topped mesas. Probably the best habitat is at the head of Parrot and Fattig Creek.

Range and Distribution.

From the scattered notes in the diaries of Montana explorers and the reports of early residents, enough material has been compiled to give a rough idea of the distribution of badland sheep. Tabulation 1 is a summary of the reports of sheep in eastern Montana and Map 2 shows this distribution and probable additional range.

Probably the three most heavily populated areas on this range, shown in black on Map 2, were the Missouri Breaks around Billy and Snow Creeks, the Glendive badlands and the Powder River Breaks. Reports do indicate that there were sheep along the Missouri from Fort Union to the Gates of the Mountains.

The Powder River herd apparently extended from the Yellowstone to the mouth of Little Powder River and were said to be found largely on the east side of Powder River.

Sheep found in the Chalk and Finger Buttes were close to the Powder River group while the range found in the Sheep Mountains of Prairie County and around Forsyth is closely connected to the Yellowstone River Breaks.

FOOD HABITS.

Feeding habits of the badland sheep are probably similar to the mountain bighorns. According to reports, native grass and fringed sage comprised

the chief food.

Audubon wrote "The Mauvais Terres are mostly formed of grayish white clay, very sparsely covered with small patches of thin grass on which Big Horns feed." It is conceivable that grama grass was the one which he meant.

There is at least some evidence that water was a factor in distribution of auduboni. On Powder River it is said that a large clear spring centered in the best sheep range, while adjacent areas, similar in other ways, were used but slightly.

One rancher had opportunity to watch a band for several days and believed that the sheep went to water every day if possible.

COMPARATIVE ABUNDANCE.

It is impossible to make a reasonable estimate as to how abundant mountain sheep were in eastern Montana. However, the range was rather limited and it is felt certain that they never reached an abundance even slightly comparable to the prairie buffalo, elk and antelope.

This species was usually found in bands of five or six to fifteen or twenty and although seen very often along the chief waterways, did not comprise a significant portion of the explorers' meat supply. One of the early residents in the Powder River Breaks said there were "dozens" of the sheep and the largest band reported was forty animals.

From this information, it must be concluded that the badland sheep, although no doubt very abundant in its own habitat, could not be classed in the astronomical numbers which the other big game of the prairie were said to have occurred.

DECIMATION OF THE BADLAND SHEEP.

All of the factors which contributed to the extinction of Audubon sheep are not known. Audubon claimed that the wolves were one of the chief enemies and probably the mountain lion and other predators of this country took their toll.

Man, however, was certainly an important factor in the decimation of this species. Reports have been heard of wagonloads of deer and sheep being taken from the Missouri Breaks and apparently a large number were taken just as a source of food.

It is believed, however, that trophy hunters were guilty of killing the last of this species.

Following is a list of the last known sheep in the various areas:

The Last Stand of the Badland Sheep

This is typical of the better mountain sheep habitat in the Missouri Breaks. It was in this area where it is believed that the last Audubon sheep was killed in 1916.

Glendive Badlands
A portion of the Yellowstone Breaks. Ideal sheep habitat in most respects. The last reported sheep was seen here in 1915.

Chalk Buttes of Carter County

Sheep were exterminated in this area in 1898. It is an "oasis-like" mesa set in the prairie with fingers of badlands extending to the Powder River Breaks.

Powder River Breaks -- 1893
Chalk Buttes -- 1898
Larb Hills -- 1914
Glendive Breaks -- 1915
Billy Creek (Missouri Breaks) -- 1916

The last known specimen of Audubon sheep was killed on Billy Creek in 1916. This was within the Snow Creek Preserve which was established in 1911 to protect this vanishing species but which for various reasons did not serve its purpose.

MOUNTAIN SHEEP RESTORATION.

One of the chief purposes behind this study was the practical applications which could be used in increasing Montana's mountain sheep population, which is in a rather precarious position at present.

An argument frequently heard in regard to the disease and lack of increase of mountain sheep at present is that this species was once an inhabitant of the prairie and when forced back to the mountains, the dampness and climatic conditions were such that it caused excessive disease.

If the evidence as presented here is correct, then it is apparent that the sheep was typically a resident of the extreme altitudes and moved from these into the lower badlands.

It is entirely possible, however, that the introduction of several bands of mountain sheep into desirable areas in the badlands would serve a dual purpose. First, it would give a breeding stock to re-populate some very desirable sheep range, and second, a study of the sheep in this environment might provide a key to the problems in the mountains.

TRAPPING AND TRANSPLANTING.

In the nature of an experimental plant, it is suggested that sheep be established in two of the most desirable areas of eastern Montana.

The first area lies in the Fort Peck Game Range in the Missouri Breaks. Here it is proposed to plant a band of Nelson's bighorn sheep to be acquired, if possible, from the Desert Game Range in Nevada.

Another area is the badlands near Glendive, Montana. This is an area of eighty square miles which has only slight economic usage and is an excellent sheep range. It is proposed that a plant be made here from stock in the Sun River area.

When these plants are made, the areas should be made into Game Sanctuaries and patrolled intensively. A careful study should also be made to determine the results of this work.

Table 1

BADLAND SHEEP REPORTED IN MONTANA

| Map Key | Area | Locality | Number of Sheep | Authority for Report | Date |
|---|---|---|---|---|---|
| 1 | Missouri Breaks | Arrow River | 4 killed | Lewis & Ordway | 1805 |
| | " | Judith Gap & Plum Cr. | ____ | Tom Burkin-Roundup | ____ |
| | " | Snow Creek | 20 - 30 | V. C. Hooker-Baker | 1905 |
| | " | Hell & Seven Blackfoot Cr. | Most abundant | H. Cosner - Malta | ____ |
| | " | Fort Union to Big Mouldy Cr. | Many | Lewis & Ordway | 1805 |
| | " | Fort Union | 5 | Audubon | 1843 |
| | " | Larb Mills | 1 killed | Last Report | 1914 |
| | " | Billy Creek | 1 killed | Last Report | 1916 |
| | " | McCone Co. | ____ | H. F. Schlosser, Miles City | ____ |
| 2 | Bull Mts. | Head Fattig Cr. | 40 | Questionable report | 1890? |
| | Bull Mts. | Head Fattig Cr. | 10 | | |
| 3 | Glendive Badlands | Glendive Badlands | 26 | Ray Lowe, Glendive | Before 1900 |
| | " | Glendive Badlands | 18 | Andrew Larson, Glendive | 1894 |
| | " | Blue Mountain | 1 Ram | Same as above | 1915 |
| 4 | Powder River Breaks | Yellowstone to Little Powder River | ____ | Dan Bowman, Miles City | ____ |
| | " | Locate Creek | 1 killed | H. F. Schlosser, Miles City | 1883 |
| | " | N & W of Terry | ____ | Same as above | ____ |
| | " | Knowlton | 24 | Dan Bowman, Miles City | 1890? |
| | " | Corral, Fennel & Sweet Crs. | ____ | Same as above | ____ |
| | " | Myers Cr. - Knowlton | 1 killed | Same as above | 1893 |
| 5 | Yellowstone Breaks | Crooked Cr. - Prairie Co. | ____ | H. F. Schlosser, Miles City | ____ |
| | " | Big Sheep Mts. | ____ | Several | ____ |
| | " | Little Sheep Mts. | ____ | Several | ____ |

Table 1 (Continued)

BADLAND SHEEP REPORTED IN MONTANA

| Map Key | Area | Locality | Number of Sheep | Authority for Report | Date |
|---|---|---|---|---|---|
| 6 | Carter Co. | Alkali-Teepe Creeks | 22 | W. H. Peck, Ekalaka | 1898 |
| | Carter Co. | Chalk Buttes | 3 | Same as above | 1898 |
| | Carter Co. | Sheep Mts. | ____ | Same as above | ____ |
| | Carter Co. | Finger Buttes | ____ | Same as above | ____ |
| 7 | Rosebud Co. | Big & Little Porcupine | ____ | H. F. Schlosser, Miles City | ____ |
| | Other Historical | Snowy Mts. S. & Moccasins | ____ | _____ | ____ |
| | | Belts | ____ | _____ | ____ |
| | | Highwoods | ____ | Tom Burkin | ____ |
| | | Castles | ____ | Roundup | ____ |
| | | Gates of Mts. | Best | _____ | ____ |